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Author(s): Berthold Laufer

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ASBESTOS AND SALAMANDER,

AN ESSAY IN CHINESE AND HELLENISTIC FOLK-LORE.

BY

BERTHOLD LAUFER.



It is my object, not to write a history of asbestos and its application with reference to human culture, but to unravel the curious traditions entertained by the Chinese regarding this marvellous production of nature, and to correlate their notions of it with the corresponding thoughts of the ancients, the Syrians and Arabs, and of mediæval Europe. Without due consideration of the Western folk-lore, the Chinese traditions, the elements of which are thoroughly based on Occidental ideas, would forever remain a sealed book. We are indebted to A. WYLIE¹ for a most scholarly study, *Asbestos in China*, which contains an almost complete array of Chinese sources relative to the subject; in fact, without his energetic pioneer-labor, the present investigation could not have been carried to the point to which it has now attained. My obligations to him for his able research-work are acknowledged in each and every case. The present state of science, however, has permitted me to go far beyond the results which Wylie was able to reach a generation ago. WYLIE² merely noted in the most general way that the accounts

¹ *Chinese Researches*, section iii, pp. 141—154 (Shanghai, 1897).

² *L. c.*, p. 149.

of the Chinese corroborate the statements of ancient classical writers, mainly emphasizing the point that the Chinese, in the same manner as the ancients, mention handkerchiefs or napkins woven from asbestos. No attempt, however, was made by him to explain all the curious lore that was lavishly accumulated on top of this subject. Here WYLIE¹ merely offered the remark, "The speculations of native writers as to the material of which it was made will probably not be thought equally worthy of credit with the bare recital of facts which came under their notice. In early times they appear not to have suspected that it was a mineral product, but have contented themselves with applying to the animal and vegetable kingdoms respectively for a solution of the difficulty." From the viewpoint of comparative folk-lore and Chinese relations with the West, these speculative theories which partially take their root in Hellenism certainly present most attractive material for study. Further, Wylie's representation of the matter suffers from various defects. It is not well arranged in chronological or any other order, and the sources are not sifted critically. Moreover, as admitted by himself, he did not succeed in identifying most of the geographical terms to be found in the Chinese texts.² At present this task is greatly facilitated, chiefly thanks to P. Pelliot's learned researches, which form the basis of many an important conclusion reached on the following pages. The geographical point of view is indispensable in this case, as only in this manner is it possible to trace the routes over which ideas have wandered.

By "asbestos" we understand the fibrous varieties of tremolite, actinolite, and other kinds of amphibole, the fibres of which are sometimes very long, fine, flexible, and easily separable by the fingers,

¹ *L. c.*, p. 144.

² Also HIRTH (*China and the Roman Orient*, p. 252) confessed that he was unable at the time when he wrote (1885) to identify these names.

and look like flax. The colors vary from white to green and wood-brown. The name "amiantus" is now applied usually to the finer and more silky kinds. Much that is called asbestos is chrysotile, or fibrous serpentine.¹ Asbestos, then, is a term of generic character, applied to the peculiar fibrous form assumed by several minerals, and not a name given to any one particular species; the asbestiform condition being simply a peculiar form under which many minerals, especially serpentine, occasionally present themselves. The varieties of asbestos are very numerous. They are all silicates of lime and magnesia or alumina, and commonly occur in crystalline rocks of metamorphic origin. The most valuable property of asbestos, its infusibility, is due to the large proportion of magnesia in its composition, which, like lime, has proved absolutely infusible at the highest temperatures attainable in furnaces or otherwise. Under the blowpipe a single fibre will fuse into a white enamelled glass or opaque globule, but in the mass some varieties have been known to resist the most intense heat without any visible effect. Chrysotile, however, if exposed for some time to long-continued heat, will lose somewhat of its tenacity and silkiness, and become rough and brittle.² The word "asbestos," then, in its present loosely-defined significance, is rather a commercial than a mineralogical term, and covers at least four distinct minerals, having in common only a fibrous structure and more or less fire and acid proof properties.³ It will be well to keep this in mind, as it cannot be expected that the Greek, Roman, Arabic, and Chinese writers, in their accounts of asbestos, should have in their minds a uniform and well-defined mineralogical species.

¹ E. S. DANA, *System of Mineralogy*, p. 389 (New York, 1893).

² R. H. JONES, *Asbestos, its Properties, Occurrence, and Uses*, pp. 13, 22, 23 (London, 1890).

³ G. P. MERRILL, *Notes on Asbestos and Asbestiform Minerals* (*Proc. U.S. Nat. Mus.*, Vol. XVIII, 1895, p. 281).

ASBESTOS IN CLASSICAL ANTIQUITY.—It is possible that Theophrastus (372—287 B.C.)¹ makes mention of asbestos, although this name does not appear in his writings. He states, "In the mines of Scaptesylos is found a stone, in its external appearance resembling rotten wood, which is kindled by oil poured over it; when the oil is consumed, the stone itself ceases to burn, as though it were not affected by fire." Theophrastus discusses in this connection the different effects which the action of fire may bring about upon stones; but while he may have had asbestos in mind, this conclusion is by no means forcible. Others hold, for instance, that he speaks here of bitumen,² and this view seems more probable.

STRABO (circa 63 B.C.—A.D. 19; x, 1, § 6) states that "in the quarries near Carystus, at the foot of Mount Ocha in Euboea, is extracted a stone which is combed like wool, and spun and woven; of this substance, among other things, are made napkins (*χειρόμακτρα*) which, when soiled, are thrown into the fire, and whitened and cleaned, in the same manner as linen is washed."³

¹ *De lapidibus*, 17 (opera ed. F. WIMMER, p. 343).

² JOHN HILL, in his still very useful work *Theophrastus's History of Stones with an English Version, and Critical and Philosophical Notes* (p. 40, London, 1746), makes the following interesting comment on this passage: "It is much to be questioned whether this was the true original reading, and genuine sense of the author; in all probability some errors in the old editions have made this passage express what the author never meant to say. The substance, and indeed the only substance described by the other ancient naturalists as resembling rotten wood, is the gagates or jet before mentioned among the bitumens; but that has no such quality as the author has here ascribed to this stone of Scaptesylos. The ancients, it is to be observed, had a common opinion of the bitumens, that the fire of them was increased by water, and extinguished by oil; and very probably this was the sentiment originally delivered here by the author, however errors upon errors in different copies of his works may since have altered the sense of them. The stone itself was probably a bitumen of the lapis Thracius kind, as the place from whence it has its name was a town of that country."

³ Compare F. DE MÉLY, *Lapidaires grecs*, p. 14. Carystus (now Castel Rosso) was a city situated at the southern extremity of the island of Euboea, south of the mountain Ocha (now St. Elias). It was there that in 490 B.C. the Persian expedition under Datis and Artaphernes landed (HERODOTUS, vi, 99). At the time of Plutarch the mine was exhausted (see below). Celebrated was the marble of Carystus (mentioned also by Strabo,

DIOSCORIDES (v, 156) of the first century A.D., who designates asbestos by the name "amiant,"¹ says that this stone is found on Cyprus, and resembles alum, that may be cleft (στρυπηρίᾳ σχιστῆ).² Being flexible, it is made by traders into tissues for the theatre. Thrown into the fire, they flame up, but come out more resplendent without having been attacked by the fire.³

APOLLONIUS DYSCOLUS, who lived in the first half of the second century A.D., has the following interesting notice on asbestos:⁴ "Sotacus, in his treatise on stones,⁵ says in regard to the stone called Carystius⁶ that it has woolly and downy excrescences, and that napkins are spun and woven from this mineral. It is twisted also into lamp-wicks which emit a bright light and are inexhaustible.⁷ When these napkins are soiled, their cleaning is performed not by means of washing in water, but brush-wood is burnt, the napkin

the quarries of which are still preserved (see LENZ, *Mineralogie der alten Griechen und Römer*, p. 59).

¹ Greek ἀμίαντος ("undefilable"), from μιᾶίνω ("to soil, defile").

² Regarding alum see M. BERTHELOT, *Collection des anciens alchimistes grecs*, Vol. I, p. 237.

³ F. DE MÉLY, *l. c.*, p. 24. The Arabic version (L. LECLERC, *Traité des simples*, Vol. II, p. 414) says that it resembles the alum of Yemen, and speaks of tissues without reference to theatrical use. J. YATES (*Textrinum Antiquorum*, p. 359) remarks that the epithet ἱμαντῶδους may have referred to that variety of asbestos which is now called mountain-leather and commonly found with the fibrous asbestos.

⁴ *Historiae mirabiles*, XXXVI (*Rerum naturalium scriptores Graeci minores*, ed. KELLER, Vol. I, p. 52).

⁵ A work which is lost now. Sotacus lived in the third or perhaps even toward the close of the fourth century B.C. He is chiefly known to us from quotations in Pliny who cites him on seven occasions. Judging from the exact definitions of localities which he gave in order to determine stones and jewels according to their origin, he appears to have travelled a good deal in Hellas and on the Greek islands. The then known world from India to Britannia and Aethiopia supplied him with material for observations; and his definitions, as we see from Pliny, were accepted as models by subsequent scholars. He dealt also with the employment of the single stones, particularly in medicine and magic (compare F. SUSEMIHL, *Geschichte der griechischen Litteratur in der Alexandrinerzeit*, Vol. I, pp. 860—861).

⁶ That is, stone from Carystus (see the above citation from Strabo).

⁷ Hence arose the name asbestos (ἄσβεστος) which means "inextinguishable."

in question is placed over this fire, and the squalor flows off;¹ while the cloth itself comes forth from the fire brilliant and pure, and is again utilized for the same purposes. The wicks remain burning with oil continually without being consumed. The odor of such a wick, when burnt, tests and detects the presence of epilepsy in persons.² This stone is produced in Carystus, from which place it received its name; in great abundance, however, on Cyprus, as you go from Gerandrus to Soli,³ under rocks to the left of Elmaeum. At the time of the full moon the stone increases, and again it decreases with the waning of the moon."⁴

PAUSANIAS (I, 26) narrates that the golden lamp made by Callimachus for the temple of Athene Polias in the Acropolis of Athens, which was kept burning day and night, had a wick of Carpasian flax (*λίνου Καρπασίου*), the only kind of flax that is indestructible by fire.⁵ PLUTARCH (*circa* A.D. 46—120), in his *De oraculorum defectu*,

¹ This is a correct estimation of the process. The throwing into the fire of asbestine cloth, narrated in so many texts, Western and Eastern, is of course not to be taken literally; the cloth was simply put over a charcoal fire. There is no reason to accede to the opinion of J. T. DONALD (*Some Misconceptions concerning Asbestos, Engineering and Mining Journal*, Vol. LV, 1899, p. 250) that these stories "are to a large extent mythical; certainly, if true, the articles in question were not made of asbestos."

² PLINY (XXVIII, 68, § 226) says the same about the smell arising from burnt goat's horns or deer's antlers (*morbum ipsum deprehendit caprini cornus vel cervini usti nidor*).

³ A city on the north coast of Cyprus.

⁴ A similar observation is referred by PLINY (XXXVII, 67, § 181) to the selenitis ("moon-stone"), which contains an image of the moon, and reflects day by day the form of this luminary while waxing and waning, if this is true (*selenitis... imaginem lunae continens, redditque ea in dies singulos crescentis minuentisque sideris speciem, si verum est*). According to DIOSCORIDES (v, 159), the selenitis is found at night at the time of the waxing moon, and, pulverized, the stone is administered to epileptics. It thus seems that the last clause of Apollonius, as well as his reference to epilepsy, were inspired by traditions pertaining properly to selenitis. The latter, in my opinion, denotes a variety of mica, and it will be seen that the Chinese also know of a stone in which notions of mica and asbestos are blended. Ibn al-Baitār, in his Arabic rendering of Dioscorides' *Materia Medica*, translated the Greek *amiantos* by *al-ṭalk* (that is mica, not our talc).

⁵ Asbestos from the vicinity of Carpasus, a town in the north-east corner of Cyprus, now called Carpas.

mentions napkins, nets, and kerchiefs of this material, but adds that it was no longer found in his time, only thin veins of it, like hairs, being discoverable in the rock.¹ There was further asbestine cloth for enveloping the ashes of cremated bodies, as stated by Pliny. As in other matters, so likewise on asbestos we owe to Pliny the most detailed notes.

PLINY knew asbestos of two localities,—Arcadia and India. That found in the mountains of Arcadia is of an iron color.² He has the following notice regarding asbestine cloth: "An invention has been made of a kind of material which cannot be consumed by flames. It is styled 'live,' and I have seen at banquets table-cloths made from it and burning over a fire. When the dirt was thus removed, they came forth from the fire brighter than water would have cleaned them. Funeral garments are made of this stuff for the kings to separate the ashes of the body from those of the pyre. This substance is found in the deserts of India scorched by the sun, where no rains fall, in the midst of deadly serpents, and thus becomes accustomed to live³ in the blaze. It is but rarely found, and difficult to weave owing to the shortness of its fibres. Its color is red by nature, and becomes white only through the action of fire. When found in its crude state, it equals the price of excellent pearls. In consequence of its natural properties it is called by the Greeks *asbestinon*.⁴ Anaxilaus⁵ is responsible for the statement that a tree enveloped by this linen is felled without the

¹ Among the Greek alchemists the word "asbestos" assumed the significance "lime;" thus Zosimus wrote a treatise on the latter under the title "Asbestos" (M. BERTHELOT, *Origines de l'alchimie*, p. 185).

² Asbestos in Arcadiae montibus nascitur coloris ferrei (XXXVII, 54, § 146).

³ *Vivere*; this description accounts for the above attribute "live" (*vivum*).

⁴ That is, inextinguishable, inconsumable.

⁵ A physician and Pythagorean philosopher who was banished by the Emperor Augustus in 28 B.C. on a charge of practising magic.

blows of the axe being audible. Hence this linen occupies the foremost rank the world over.”¹

In another passage Pliny mentions amiantus as resembling alum (*alumen*) in appearance,² and losing nothing from the agency of fire. It resists all practices of sorcery, particularly those of the Magi.³

The notes of the ancients are very plain, but deficient in facts. They give us the localities where asbestos was found, state the kind of products made from it, and point out its power of resistance to fire. We hear nothing, however, about the mode of mining the mineral, or preparing, spinning, and weaving its fibres.⁴ Above all, it should be borne in mind that no theory regarding the origin and nature of asbestos is handed down to us from classical antiquity. Pliny's idea that its fire-resisting quality is bred by the tropical sun of India, can hardly be regarded as such, and is no more than an expression of his personal opinion. Several authors, it is true, have ascribed to Pliny a belief in the vegetal origin of asbestos, but this is an unfounded assumption. DANA⁵ peremptorily says that Pliny supposed asbestos to be a vegetable product. BOSTOCK and RILEY,⁶ pointing to the word *mappa*, as boldly assert that “he

¹ Inventum iam est etiam quod ignibus non absumeretur. Vivum id vocant, ardentisque in focis conviviorum ex eo vidimus mappas sordibus exustis splendescentes igni magis quam possent aquis. Regum inde funebres tunicae corporis favillam ab reliquo separant cinere. Nascitur in desertis adustisque sole Indiae, ubi non cadunt imbres, inter diras serpentes, adsuescitque vivere ardendo, rarum inventu, difficile textu propter brevitatem. Rufus de cetero colos splendet igni. Cum inventum est, aequat pretia excellentium margaritarum. Vocatur autem a Graecis ἀσβεστόν ex argumento naturae. Anaxilaus auctor est linteo eo circumdatam arborem surdis ictibus et qui non exaudiantur caedi. Ergo huic lino principatus in toto orbe (XIX, 4).

² AULUS GELLIUS (*Noctes atticae* [circa A.D. 175] xv, 1) mentions a wooden tower for the defence of the Piraeus, which could not be set on fire by Sulla, because it was coated with alum.

³ Amiantus alumini similis nihil igni deperdit. Hic veneficiis resistit omnibus, privatim Magorum (XXXVI, 31, § 139).

⁴ BLÜMNER, *Technologie*, Vol. I, 2d ed., p. 205.

⁵ *System of Mineralogy*, p. 389.

⁶ *Natural History of Pliny*, Vol. III, p. 136.

evidently considers asbestos to be a vegetable, and not a mineral production.”¹ Pliny indeed makes no statement whatever to the effect that asbestos is a plant or the product of a tree, as we hear, for instance, in China; neither is there any such testimony in any other classical source. On the contrary, all Greek authors distinctly speak of asbestos as a mineral. Moreover, Pliny most positively regarded both asbestos and amiantus as minerals; otherwise he would not have listed them, as we have seen, in his books xxxvi and xxxvii, which are devoted to mineralogy. For this reason I am convinced that throughout classical antiquity asbestos was considered as nothing but a mineral substance. This is most strongly corroborated by the fact that the ancients were familiar with at least three mines in their own dominion,—Carystus, Cyprus, and Arcadia; and the people who mine asbestos are assuredly familiar with its true nature, and cannot possibly believe in its vegetal provenience. Pliny has inserted his principal notice of asbestos in his book on textiles, because it was as a textile that the substance was chiefly utilized and known. Certainly this textile deserved the name “linen;” in fact, it could not have been termed anything else. We ourselves still speak of asbestos-cloth, and entertain no thought of a vegetable product in this connection. There are vegetal, animal, and mineral fibres, and any material woven from these may be called cloth. The verb *nascitur* (“it is born, it grows”), used by Pliny, does not allow of inferences, any more than the word *linum*. This term does not necessarily refer to plant-life; on the contrary, Pliny employs it also with reference to minerals. Thus the Indian *adamas* does not “grow” (that is, occur) in a stratum of gold.²

¹ Even so cautious a worker as E. O. VON LIPPMANN (*Abhandlungen*, Vol. I, p. 17) wrongly makes Pliny say that asbestos is an incombustible flax. Pliny does not express himself in this manner.

² *Indici non in auro nascentia* (xxxvii, 15, § 56); or the *selenitis* is said to grow in

The notion of the vegetal character of asbestos, indeed, did not exist in classical antiquity, but it is Hellenistic and seems to have sprung up somewhere in the anterior Orient. The earliest source to which I can trace it is the Greek Alexander Romance (*Pseudo-Callisthenes*, III, 22) in which is described a dining-room of imperishable wood in the palace of Queen Candace,—not exposed to putrefaction, and inconsumable by fire. Other manuscripts, however, read ἀμιάντων and “stones” instead of “wood;” so that the passage is now rendered, “There was there also a dining-room of incombustible amiantus.”¹ A Syriac work on natural history of uncertain date, wrongly ascribed to Aristotle, in which Syriac translations of the Homilies of Basilus the Great and the Physiologus and several other unknown books have been utilized, makes a distinct allusion to an “asbestos tree:” “This tree is styled ‘The Constant One.’ When a man takes a piece of it and flings it into a very hot bath, the latter becomes tepid, as though it had never experienced fire. Also a fire-stove which is set in flames is extinguished and cools off; likewise a baking oven and chimney is extinguished as soon as a piece of that tree is thrown into them.”² This notice is followed in the same work by the description of the salamander, which, as will be noticed farther on, plays such a signal part in the mediæval legends of asbestos. The tree-asbestos was adopted also by the Arabic writer Abū Dulaf (below, p. 329). It turns up also in China.

The scarcity of information which the ancients have left to us on the subject of asbestos is to some extent made good by three relics of asbestos tissues still preserved in Italy. One found at Puzzuolo in 1633 belonged to the Gallery Barberini. Another, in

Arabia (nasci putatur in Arabia [67, § 181]). In a similar manner *croître* was employed in French: R. DE BERQUEN (*Les merveilles des Indes orientales*, p. 15, Paris, 1669), for instance, has, “Cette precieuse pierre croist en plusieurs endroits du monde.”

¹ A. AUSFELD, *Der griechische Alexanderroman*, p. 99.

² K. AHRENS, *Buch der Naturgegenstände*, p. 80.

the Library of the Vatican, was discovered in 1702 a mile outside of the Gate of Rome, called Porta Maior; it was a corpse-cloth, five feet wide and six feet and a half long, coarsely spun, but as soft and pliant as silk, enclosing the skull and calcined bones of a human body,—discovered in a marble sarcophagus, thus furnishing a remarkable confirmation of Pliny's statement. The deceased, judging from the sculptured marble, was a man of rank who is supposed to have lived not earlier than the time of Constantine. A third piece of asbestine cloth, of considerable dimensions, is shown in the Museum Borbonico at Naples; it was found at Vasto in the Abruzzi.¹

The early Chinese notices of asbestos bear the same sober character as those of the classical authors.

EARLY IMPORTATION OF ASBESTOS INTO CHINA.—The Chinese first became acquainted with asbestos through their trade with the Roman Orient. Indeed, the first authentic notices of a product from this mineral in the Annals refer to the territory of western Asia. The *Wei lio* 魏略, written by Yü Huan between 239 and 265,² enumerates asbestos-cloth among the products frequently found in Ta Ts'in (the Roman Orient).³ The same statement is made in the Annals of the Later Han Dynasty;⁴ likewise in those of the Ts'in and Liu Sung Dynasties.⁵ The fact that Ta Ts'in produces asbestine cloth is mentioned also in the famous Nestorian inscription of Singan fu. The term used in the Annals is *huo huan pu* 火浣布 (literally, "cloth which can be cleansed by fire"), evidently suggested by the stories of the ancients. After the example of WYLIE,⁶ I use

¹ J. YATES, *Texterium Antiquorum*, pp. 359, 360.

² See CHAVANNES, *T'oung Pao*, 1905, pp. 519—520; and PELLIOU, *Bull. de l'Ecole française*, Vol. VI, 1906, p. 364.

³ HIRTH, *China and the Roman Orient*, p. 74.

⁴ *Hou Han shu*, Ch. 118, p. 4 b.

⁵ HIRTH, *l. c.*, pp. 40, 45, 46, 61; CHAVANNES, *T'oung Pao*, 1907, p. 183.

⁶ *Chinese Researches*, section III, p. 141.

the term "fire-proof cloth" as a convenient synonyme, though this meaning is not directly conveyed by the Chinese expression.

The alleged philosopher Lie-tse¹ mentions a tribute of asbestos-cloth to King Mu of the Chou dynasty (1001—946 B.C.) on the part of the Western Jung. Asbestos is characterized there as follows: "The fire-proof cloth, in order to be cleansed, was thrown into the fire. The cloth then assumed the color of fire, and the dirt assumed the color of the cloth. When taken out of the fire and shaken, it was brilliantly white like snow." This text is not authentic, but retrospective, and cannot be older than the Han period. In the same manner as the diamond was a product hailing from the Roman Orient, so also was asbestos.²

In like manner the text of the *Chou shu* 周書,³ alluding to the same event as that of Lie-tse, is of a purely retrospective character, and devoid of chronological value.⁴ The matter, indeed, is not connected with King Mu or the Chou dynasty; but the fact is borne out by these two texts that under the Han (206 B.C.—A.D. 220), asbestos-cloth, together with diamond-points, was imported into China over a land-route leading from the Roman Orient by way of Central Asia.⁵

¹ Ch. 5, *T'ang wén*.

² WYLIE (*l. c.*, p. 142) seems to regard Lie-tse's text as historical; and HIRTH (*China and the Roman Orient*, p. 250) even goes so far as to say, that if the philosopher Lie-tse, whose writings are said to date from the fourth century B.C. (A.D. in Hirth's book is a misprint), can be trusted, asbestos-cloth was known in China as early as a thousand years B.C. E. FABER (*Naturalismus bei den alten Chinesen*, p. 132), in his translation of Lie-tse, justly wondered that things like asbestos were already known in times of such hoary antiquity; but certainly they were not. The alleged *kun-wu* 鍬鋸 sword mentioned in Lie-tse is not, as hitherto believed, a sword, but a diamond-point.

³ See CHAVANNES, *Mémoires historiques de Se-ma Ts'ien*, Vol. V, p. 457.

⁴ The text of the *Chou shu* has passed into the *Po wu chi* (Ch. 2, p. 4b, ed. printed at Wu-ch'ang).

⁵ King Mu was the chosen favorite and hero of Taoist legend-makers, to whose name all marvellous objects of distant trade were attached (in the same manner as King Solomon and Alexander in the West). The introduction of the Western Jung is emblematic of the intermediary rôle played by Turkish tribes in the transmission of goods from western Asia to China.

Wylie was inclined to believe that the earliest allusion to asbestos occurs in the *Shi i ki* 拾遺記, where it is said that the people of Yü-shan 羽山 brought yellow cloth for presentation to the Emperor Shun. This, according to him, is not very distinct; but as we learn from the same authority that the same nation, on two later occasions, brought an offering of fire-proof cloth, it seems not unfair to infer that the former offering was of a similar character. That work, however, as stated by WYLIE elsewhere,¹ has little historical value. It was written by Wang Kia 王嘉 of the fourth century; but this work is not preserved, having been afterwards disarranged and partially destroyed. Even if the passage in question were traceable to Wang Kia, our belief in it would not be strengthened; for no authentic work of the pre-Christian era contains any allusion to this matter. Asbestos was found on Chinese soil only in post-Christian times; and Chinese notions regarding asbestos being, as will be seen, to a large extent based on Western folk-lore, it is reasonable to conclude that the Chinese were not acquainted with asbestos before their contact with the Roman Orient. The various accounts of the *Shi i ki* about tributes of asbestos, however, point to the fact that this material came from Western regions.

General Liang-ki 梁翼, who lived under the Emperor Huan 桓 (147—157) of the Han dynasty,² had a costume made from asbestos-cloth, which he used to wear on the occasion of great banquets. He would insist on declining the wine-cup till it was spilled on his suit; and then with feigned anger he would take it off, ordering it to be thrown into the fire. It blazed up as if it were reduced to ashes; but the stains being removed, and the fire extinguished, the cloth appeared bright and clean, as if it had been purified with lees.³

¹ *Notes on Chinese Literature*, p. 192.

² He died in 159 (GILES, *Biographical Dictionary*, p. 478).

³ Compare WYLIE, *Asbestos*, p. 143. This text is handed down under the name of

A report of incontestable authenticity concerning asbestos-cloth being sent as tribute to China refers to the second month of the year 239, in the time of the Three Kingdoms, when envoys from an unnamed country of the Western Region (*Si Yü*), introduced at the Court by means of double interpreters, offered fire-proof cloth to Ts'i Wang Fang 齊王芳 (240—253) of the Wei dynasty. The Emperor directed his military staff to test it, and to proclaim the result to the officers.¹ The intention was perhaps implied to make use of this material for army purposes. Under the Wei, also, the tradition was upheld that early under the Han, gifts of such cloth had been presented by Western countries. Two sovereigns of the Wei lent expression to an ill-founded scepticism as to the actual existence of this substance,—a belief which was not shared by the Taoist Ko Hung 葛洪 of the fourth century.² Ko Hung inaugurates a new period in the study of this subject on the part of the Chinese. Under the Han and throughout the third century, the Chinese accepted asbestos products as a fact, without inquiring into the nature of the mineral or the causes of its wonderful properties. They were satisfied to state merely the effects of its properties. Ko Hung is the first Chinese author to render an account of the origin of asbestos in the romantic spirit appropriate to the Taoist school. The ideas which he expounded, however, are closely inter-

Fu-tse 傅子, who lived in the latter part of the fourth century, and appears in P'ei Sung-chi's commentary to *San kuo chi* (*Wei chi*, Ch. 4, p. 1). HIRTH (*China and the Roman Orient*, p. 251) wrongly ascribes it to the text of *Wei chi* itself; he aptly reminds us of the jest practised by the Emperor Charles the Fifth, who astonished his guests after dinner by exposing an asbestos table-cloth to a fire. In the *Encyclopædia Britannica* (Vol. II, p. 714) this anecdote is connected with Charlemagne; R. H. JONES (*Asbestos*, p. 3) allows both Charleses to pass. The one attribution is as true as the other.

¹ *San kuo chi* (*Wei chi*), Ch. 4, p. 1.

² These texts have been translated by WYLIE (*l. c.*, pp. 150—151): they are therefore not reproduced here, especially as they bear no immediate relation to our subject, which is to trace the development of Chinese notions of asbestos in their dependence on Western beliefs. Compare also the analogous text in the *Yü kien* 寓簡 (WYLIE, *Notes*, p. 165), Ch. 3, p. 2 b (ed. of *Chi pu tsu chai ts'ung shu*).

twined with those which the further development of the matter at the end of the classical period in the Occident brought to life. The sober and prosaic notices of the Han and Wei periods thoroughly coincide with those of the classical authors, while Ko Hung's thoughts are on the same level as those of the post-classical writers. In their efforts to find a plausible explanation for the origin of asbestos, the Taoist nature-philosophers directed their thoughts toward the animal and vegetable kingdoms, now explaining it as the hair of a beast, now as the fibre of a plant, and also, through the introduction of the activity of a volcano, welding these two theories into one. Nobody as yet has unravelled the mystery of how these strange speculations arose.¹ As regards the supposed animal origin of asbestos, the gist of the Chinese accounts in general is that there is a fiery mountain (volcano) on which lives an animal lustrous with fire, about the size of a rodent, covered with hair of unusual length and as fine as silk. Ordinarily it dwells in the midst of the fire, when its hair is of a deep-red color; but sometimes it comes out, and its hair is then white. On a dark night the forest is visible from the reflection of the animal's lustre. It is put to death by being sprinkled with water, whereupon its hair is spun and woven into cloth, which makes what is called fire-proof cloth. If the cloth becomes soiled, it is purified by fire. The solution of this riddle may be betrayed in advance: the Chinese animal yielding asbestos

¹ CHAVANNES (*Bulletin de l'École française*, Vol. III, p. 438) indicates an interesting text in *Pei shi* (Ch. 97, p. 2), according to which the Emperor Yang (605—616) of the Sui dynasty despatched Wei Tsie and Tu Hing-man on a mission to the countries of the west; in the kingdom of Shi (Kesh, at present Shāhr-i-sabz) they took ten dancers, lion-skins, and hair of the rat which enters the fire (*huo shu mao*). Chavannes cites the definition given of this animal in the *Ku kin chu*, "The fire-rat enters the fire without burning; its hairs are over ten feet long; they can be made into a textile known as 'cloth washable in the fire.'" "Ce sont des fibres d'amiante ou asbeste qu'on présentait aux Chinois comme étant les poils d'un animal merveilleux," is the comment added by M. Chavannes.

is a disguise of the classical salamander, whose hair or wool was believed by the Arabs and mediæval Europe to furnish the material for asbestos textiles. The history of this subject must be studied in detail to arrive at a correct appreciation of the Chinese traditions, which, on their part, are of sufficient extent and importance to throw light back on the development of the matter in the West.

THE SALAMANDER IN GREEK AND ROMAN LORE.—An animal by the name of salamander is first mentioned by ARISTOTLE (384—322 B.C.): “On the Island of Cyprus, where copper-ore is smelted and accumulates for many days, animals are developed in the fire, somewhat larger than the big flies with short wings that go hopping and running through the fire. They die when removed from the fire. The possibility, however, that the bodily substance of some animals is not destroyed by fire, is proved by the salamander; for this creature, as it is said, will extinguish the fire while passing through it.”¹

AUBERT and WIMMER, in their edition of Aristotle’s work,² reject this passage as unauthentic, and presumably with good reason. Aristotle does not mention this animal in any other passage, and it is not clear from his text what kind of animal he understands by *salamandra*; it is also difficult to credit a scholar of the intellectual calibre of Aristotle with the belief in animals crossing fire unhurt, which belong, not to natural history, but to the realm of fable.

THEOPHRASTUS (372—287 B.C.), Aristotle’s great disciple, mentions the salamander in two of his writings as an animal which he apparently knew from personal experience. He enumerates “the lizard,

¹ “Οτι δ’ ἐνδέχεται μὴ κάεσθαι συστάσεις τινὰς ζώων, ἡ σαλαμάνδρα ποιεῖ φανερόν· αὕτη γάρ, ὡς φασί, διὰ πυρὸς βαδίζουσα κατασβέννυσσι τὸ πῦρ (*Historia animalium*, v, 19, § 106).

² *Aristoteles Tierkunde*, Vol. I, pp. 119, 515.

which is called the salamander," together with birds and the green frog, among the animals whose appearance prognosticates rain.¹ In his treatise on fire he discusses means of counteracting the force of conflagrations; for instance, vinegar, and vinegar mixed with the white of an egg. "If the power of cold is added to such a fluid," he continues, "this co-operates toward the extinction of fire, and this property is said to be found in the salamander; for this creature is cold by its nature, and the fluid flowing out of its body is sticky, and at the same time contains such a juice that it penetrates forward. This is shown by water and fruits which, when touched by it, become injurious, and usually have a deadly effect. The animal's slowness of motion is also of assistance; for the longer it tarries in the fire, the more it will contribute toward its extinction. However, it cannot extinguish a fire of any dimensions, but only one commensurate with its nature and physical ability; and a fire in which it did not dwell long enough will soon light up again."² Also Theophrastus, in the same manner as his master, reproduced a popular opinion of his time, as seen by his addition "it is said" (*φασί*); but compared with Aelian and Pliny, he is rational and reasonable to a high degree.³

ÆLIAN⁴ tells the following story of the salamander: "The salamander is not a product of fire, nor does it rise from the latter like the so-called pyrigoni;⁵ yet it does not fear fire, but, going against the flame, the animal tries to combat it like an adversary. The witnesses to this fact are the artisans and workmen dealing

¹ Καὶ ἡ σαύρα φαινόμενη ἦν καλοῦσι σαλαμάνδραν, ἔτι δὲ καὶ χλωρὸς βάτραχος ἐπὶ δένδρου ἔδων ὕδωρ σημαίνει (*De signis tempestatum*, 15; opera, ed. WIMMER, p. 391).

² *De igne*, 60 (opera, ed. WIMMER, p. 361).

³ The important text of Antigonus of Carystus will be discussed in another connection (see below).

⁴ *De natura animalium*, II, 31.

⁵ The insects mentioned in the text of Aristotle quoted above.

with fire. As long as their fires flame up brightly and further their labor, they pay no attention to this creature; but when the fires go down and become extinguished, and the bellows blow in vain, they become aware of the counteraction of the animal. Then they trace it out and visit their vengeance upon it; thereupon the fire rises again, and assists their work." In another passage of the same work (ix, 28) Aelian asserts that the hog, when swallowing a salamander, is not hurt, while men partaking of its flesh are killed. The same is expressed by Pliny: "Those in Pamphylia and in the mountainous parts of Cilicia who eat a boar after it has devoured a salamander will die, for the danger of poison is by no means indicated in the odor or taste of the meat; water and wine in which a salamander has perished, even if it has only drunk of the beverage, will also have a mortal effect." ¹ In the zoölogical portion of his great work, Pliny describes the animal thus: "The salamander is an animal of the shape of a lizard, with a star-like design. It never comes out except during heavy rains, and disappears when the sky becomes serene. Such intense cold inheres in this animal, that by its mere contact, fire will be extinguished, not otherwise than by the action of ice. The milky mucus flowing from its mouth, whatever part of the human body it may touch, causes all hair to fall off; and the spot thus touched assumes the appearance of tetter." ²

In Book xxix, where he treats the remedies derived from the animal kingdom, Pliny has devoted another chapter to the salamander.

¹ Apropos in Pamphylia et Ciliciae montuosis salamandra ab iis devorata qui edere, moriuntur: neque enim est intellectus ullus in odore vel sapore; et aqua vinumque interemit salamandra ibi inmorta vel si omnino biberit unde potetur (xi, 53, § 116). In xxix, 23, he dilates still further on the subject.

² Sicut salamandrae, animal lacertae figura, stellatum, numquam nisi magnis imbribus proveniens et serenitate desinens. Huic tantus rigor, ut ignem tactu restinguat non alio modo quam glacies. Eiusdem sanie, quae lactea ore vomitur, quacumque parte corporis humani contacta toti defluunt pili, idque, quod contactum est, colorem in vitiliginem mutat (x, 67, § 188).

The most interesting point that he makes there is this: "If the assertion of the Magi were true, that the animal is helpful in conflagrations, since it is the only creature able to extinguish fire, this experience would long ago have been made in Rome; Sextius also rejects this statement as incorrect."¹ This passage shows that there were men who disavowed this popular belief; and they are headed by Dioscorides, who affirms that it has been said, and wrongly, that the salamander remained immune on entering fire.² Further, Pliny imputes the superstition to the Persian Magi; and it may, indeed, have spread into the antique world with the diffusion of the Mithraic cult into Rome.

O. KELLER³ also holds that the fables about the salamander betray Oriental origin, but he has not succeeded in tracing their sources.⁴ Pliny's and Aelian's stories doubtless go back to the Alexandrian Physiologus, whether they may have drawn upon this work directly, or received them by way of oral tradition flowing from Alexandria. The *Physiologus* (Ch. 31) states that the salamander entering a fire-stove extinguishes the fire;⁵ and the same is found

¹ Ex ipsa quae Magi tradunt contra incendia, quoniam ignes sola animalium extinguat, si forent vera, iam esset experta Roma. Sextius...negatque restingui ignem ab iis.

² L. LECLEERC, *Traité des simples*, Vol. II, p. 235.

³ *Antike Tierwelt*, Vol. II, p. 321. Keller neglected the fundamental passage of Theophrastus regarding the salamander.

⁴ The evidence produced by Keller in favor of the Oriental origin is rather perplexing. The name "salamander," which cannot be explained from Greek, indubitably comes from Asia. Arabic and Persian offer the name by omitting the syllable *al*, and the word thus abbreviated is said to mean "poison within." It is of course impossible to derive the Greek name from Persian or Arabic; on the contrary, Arabic *samandal* سَمَنْدَل, *samandar*, *samaidar*, *semendel*, *semendul*, *samand*, *sandal*, and Persian also *sālāmandirā* سالامندرا, are derived from Greek *salamandra*, as admitted by all competent philologists (F. HOMMEL, *Namen der Säugetiere bei den südsemitischen Völkern*, p. 33; the Ethiopic Physiologus still offers the form *salmandar*; STEINGASS, *Persian-English Dictionary*, p. 642; YULE, in his *Marco Polo*, Vol. I, p. 216). The derivation from Persian *sām* سام ("fire", not "poison," which is *samm* سَم, an Arabic word) and *andar* ("within") certainly rests on mere playful popular etymology.

⁵ F. LAUCHERT, *Geschichte des Physiologus*, pp. 27, 261.

in the *Hieroglyphica* of the Egyptian priest Horapollon of the fourth century A.D.¹ The tradition, accordingly, must have been current in Egypt as early as the first or second century. Let us note right here that the *Physiologus* (Ch. 7) tells also the legend of the phoenix which cremates itself in the Temple of the Sun at Heliopolis, how on the ensuing day arises from the ashes a worm, which develops on the second day into a young bird, till on the third the phoenix itself comes out therefrom in its previous shape; for this notion has likewise been associated with the attempts to account for the origin of asbestos,—asbestos, salamander, and phoenix, all representing or yielding matters going through fire unscathed. The *Physiologus* contains no reference to asbestos; and it must be emphasized that the assimilation of the three has not taken place in classical antiquity, during which they were clearly separated. A wondrous and fabulous book of the type of the *Cyranides*, a late Greek work written between 227 and 400, would not have missed this opportunity, had such an assimilation then existed among the Greeks; but it does not mention a fire-proof textile spun from the animal's hair.²

THE SALAMANDER AND PHOENIX AMONG THE ARABS.—Old d'HERBELOT,³ even, knew that the Arabic word *samandar* designates the animal styled by us "salamander," and that Oriental authors are not in accord as to its species,—the one taking it for a kind of marten,

¹ F. HOMMEL, *Aethiopische Ueb. d. Physiologus*, p. XXXII.

² F. DE MÉLY, *Lapidaires grecs*, p. 91. This work defines the salamander as a quadruped bigger than the green lizard, and Pliny and Dioscorides also take it for a lizard. O. KELLER's (*l. c.*, p. 318) identification with *Salamandra maculata* — that is, the animal now called by us salamander (or eft, newt) — seems to me arbitrary. The amplifications of the *Cyranides* are interesting: the animal's heart renders him who carries it with him fearless of fire, intrepid in a conflagration, and incombustible; and when its heart is worn as an amulet by people burnt with fever, the fever will at once abate, etc.

³ *Bibliothèque orientale*, Vol. III, p. 192.

its hair being made into a strong stuff, which can be thrown into fire to be cleansed, when it is soiled, without being in the least damaged; others taking it for a kind of bird generated and consumed in the fire, and found only in places where a perpetual fire is entertained; others, again, describing it as an insect or reptile like a lizard,—but neither D'HERBELOT nor YULE¹ noticed that the salamander as a bird (his product "salamander's plumage" being the equivalent of "asbestos") is no other than the masqueraded phoenix of the ancients.² The climax of these curious adjustments is reached by Damīrī (1344—1405), in his *Hayāt al-hayawān*, who notes the phoenix under the title "salamander," describes it as an animal like a fox or marten, and attributes to it the yielding of asbestos: "*Samandal* سمندل is a certain bird that eats *al-bīṣ* البيش (aconite), which is a plant found in the land of China, where it is edible. It is green in that country; and when it is dry, it becomes a kind of food for the people of China without any injurious effect on them. But if it be taken away from China, even to a distance of a hundred cubits, and is then eaten, the eater of it dies instantaneously."³

¹ *The Book of Ser Marco Polo*, Vol. I, p. 216.

² JULIUS CAESAR SCALIGER (*De subtilitate ad Cardanum*, fol. 305 b, Lutetiae, 1557), however, identified it with the phoenix, "which is not entirely fabulous, but, as we read in the navigators, occurs in the interior of India, and is called by the natives *semenda*."

³ This story is found in (and is probably copied from) Ibn al-Baitār (1197—1248), who quotes Ibn Semdjūn as follows: "Some physicians report that the plant *bīṣ* بيش, grows in China toward the frontier of India, in a country called Halāhil, where alone it occurs. It is eaten as a vegetable in the country of Halāhil, toward the frontier of India. In a dried state it is an article of food for the people of the country, who experience no harm from it. When taken out of that country, if only to a distance of a hundred paces, it acts as a poison, instantly killing him who eats of it" (L. LECLERC, *Traité des simples*, Vol. I, p. 298). This text is important, inasmuch as it shows that the consumption of edible aconite did not take place in China, as Damīrī wrongly asserts, but in a border state of the Himalayan region of northern India. Damīrī's allegation appears embarrassing, as "the Chinese do not seem to have considered any of the aconites as edible" (G. A. STUART, *Chinese Materia Medica*, p. 11); neither does BRETSCHNEIDER (*Bot. Sin.*, pt. 3, pp. 252—257) know anything about such a practice. The statement of the *Pie lu* regarding one variety of aconite, that it is of a sweetish taste, only shows that there is a non-

A wonderful thing in connection with the phoenix is that it takes pleasure in fire and in remaining in it. When its skin becomes dirty, it cannot be cleansed except by means of fire. It is found largely in India.¹ It is an animal smaller in size than the fox, piebald in color, with red eyes and a long tail. Sashes are woven of its soft hair; and when they become dirty, they are thrown into fire, upon which they become clean without being burnt. Other authorities assert that the phoenix is a bird found in India, that

poisonous aconite in China. On the other hand, we know that in India only two varieties of *Napellus* are poisonous, — *Napellus* proper and *Aconitum rigidum* — while the two others, *Aconitum multifidum* and *A. rotundifolium*, are harmless and are eaten in Bhūtan (HOOKER, *Flora of British India*, Vol. I, p. 29). According to FLÜCKIGER and HANBURY (*Pharmacographia*, p. 15), the tubers of *Napellus* are taken in Kunawar as aphrodisiac. Arabic *bīṣ* is derived from Hindi *bīṣ*, the latter from Sanskrit *vishā* (*visha*, "poison"), *Aconitum ferox* (*ativishā*, *Aconitum heterophyllum*; HOERNLE, *Bower Manuscript*, p. 186). The word appears in al-Bērūnī (SACHAU, *Alberuni's India*, Vol. II, p. 159) and in Qazwīnī, who describes how the fabulous poisonous girls of India are reared on it (SILVESTRE DE SACY, *Chrestomathie arabe*, Vol. III, p. 398). Regarding aconite in India, see WATT, *Dictionary of Economic Products of India*, Vol. I, pp. 84—99 (also published as a separate pamphlet in the series *Agricultural Ledger*, No. 3, 1902); in Tibet, H. LAUFER, *Beitr. zur Kenntnis der tib. Med.*, p. 57. Much valuable and interesting material on Western and Eastern beliefs in aconite poison and its effects has been gathered by W. HERTZ, *Sage vom Giftmädchen* (*Abh. bayer. Akad.*, Vol. XX, 1893, pp. 48—52). Of course, it is not the phoenix which feeds on aconite, but the salamander as a venomous animal. Its poisonous character, inherited from the classical authors, is explained by the Arabs through this process of nutrition.

¹*PLINY (XIX, 4) attributed asbestos to the deserts of India, where, under the scorching rays of the tropical sun and among numerous deadly serpents, it acquires the property of resisting fire. Hierocles, a Greek writer of the sixth century A.D., says of the Brahmans of India that their garments are made of the soft and skin-like fibres of stones, which they weave into a stuff that no fire burns or water cleanses; when their clothes get soiled, they are thrown into a blazing fire, and come out quite white and bright (MCCRINDLE, *Ancient India as descr. in Class. Lit.*, p. 186). G. WATT (*Dictionary of the Economic Products of India*, Vol. I, p. 338) mentions two localities, — the Gokāk Taluka, in the Belgaum district in the southern Maratha country, where asbestos is used as an external application in ulcers, made into a paste, after rubbing it down with water; and the country to the south and west of the Kurum River, Afghanistan, where it is medicinally employed and made into brooms and rough ropes, and padding for saddles. Watt imparts a vernacular name for asbestos, *shankha* [*ṣaṅkha*]-*palita*, which he translates "wick made of shells." On Ceylon, asbestos is found, but is not mined commercially (J. C. WILLIS, *Ceylon*, p. 3, Colombo, 1907).

lays its eggs and produces its young in fire. It possesses the property of being unaffected by fire. Sashes are made of its feathers and taken to Syria. If one of them becomes dirty, it is thrown into fire, which consumes the dirt over it, but the sash itself is not burnt. Ibn-Khallikān states, 'I have seen a thick piece of it woven in the shape of a belt for a riding beast throughout its length and breadth. It was put into fire, but the fire had no effect on it whatever. One end of it was then dipped in oil and left over the burning wick of a lamp, upon which it lighted up and remained so for a long time, after which the flame was extinguished; and it was found to be in the same condition as before, unaltered in any way.' He further states, 'I have read in the writing of our shaikh, the very learned Abd-al-Laṭīf, that a piece of *samandal* a cubit in breadth and two cubits in length was presented to the sovereign of Aleppo. They kept on dipping it in oil and lighting it up, until the oil was exhausted, but yet it remained as white as it was.' Farther on, Damīrī mentions the salamander under the name *samandar* سمندر and *samaidar* سميدار as "a certain animal well known to the people of India and China, according to Ibn-Sīdah."¹

Damīrī has compiled his information from the writings of his predecessors. The earliest Arabic notice of the *samandal*-phoenix, as far as I know, occurs in the *Adjaib al-Hind* عجائب الهند ("The Wonders of India"), written in the tenth century, where the bird is localized on one of the Islands of Wāqwāq الوقواق: "It can enter fire without burning itself, and remain there long without eating anything but earth."² This work, however, while naming the phoenix

¹ A. S. G. JAYAKAR, *Ad-Damīrī's Zoological Lexicon*, Vol. II, pt. 1, pp. 79—81 (Bombay, 1908). G. FERRAND (*Textes relatifs à l'Extrême-Orient*, Vol. I, p. 248) objects to Jayakar's translation of *samandal* by "phoenix;" but Jayakar is certainly right. The three ideas of asbestos, salamander, and phoenix are assimilated in this notion.

² LITH and DEVIC, *Livre des merveilles de l'Inde*, p. 172. L. M. DEVIC, in his separate translation of this work (p. 204, Paris, 1878), has this comment: "Semendel ou

for the salamander, makes no reference to a fire-proof textile obtained from the animal. As shown below (p. 328), the geographer Yāqūt (1179—1229) mentions the popular belief that asbestos is the plumage of a bird. In regard to the Caliph Māmūn, it is told that the Indian King Dehim presented him with a skin of the bird *samandal* which no fire was able to consume.¹

If the Chinese, as will be seen, made the salamander a rodent, this zoölogical feat meets a parallel among the Arabs. Qazwīnī enumerates the *samandalun* or *sandalun* as his fifth kind of rat, and describes it as a species of rat that enters fire, recording the same as Dāmīrī relates about the phoenix (above, p. 319); adding

Semendoul est le nom arabe et persan de la salamandre, animal fantastique sur la nature duquel les Orientaux ne s'accordent guère; les uns en font un quadrupède, d'autres un oiseau, d'autres enfin un reptile, tous lui attribuant d'ailleurs la faculté de vivre dans le feu sans se brûler. Marco Polo désigne par ce nom l'amiante." No Arabist as yet seems to have conceived the notion that this tradition becomes intelligible only if we combine the three classical traditions concerning asbestos, salamander, and phoenix associated in post-classical time by the common idea of their incombustibility; hence we meet in Arabic literature accounts of asbestos termed "salamander" which is an animal interpreted as a reptile, phoenix, and finally also as a mammal. — G. FERRAND (*Journal asiatique*, 1904, Mai-Juin, pp. 489—509) has advanced the theory that the one of the two Wāqwāq spoken of by the Arabic writers should be identified with Madagascar (the other is Japan, *Wa-iuk* 倭國; compare also the notice of CHAVANNES, *T'oung Pao*, 1904, pp. 484—487). In an additional notice (*Journal asiatique*, 1910, Mars-Avril, pp. 321—327) FERRAND admits that Wāqwāq may be identified also with Java-Sumatra. In his admirable work *Textes relatifs à l'Extrême-Orient* (Vol. I, p. iv), he adds to these possibilities also East Africa. While not contesting the ingenuity of Ferrand's theory, it is not convincing in all parts (it is chiefly based on the supposed etymology of Wāqwāq being derived from the native names for Madagascar, *Vahuaka*, and for the tree *vakua*). The authority of al-Bērūnī, however, is not to be disparaged, according to whom Wāqwāq belongs to the Qumair Islands; the latter, according to his statement, belong to the Dīva Islands (Maledīva and Laccadīva); further, as assured by the same author, Qumair is not, as believed by the common people, the name of a tree, but of a people whose color is whitish, and who practise the religion of the Hindu (SACHAU, *Alberuni's India*, Vol. I, p. 210). Wāqwāq is here clearly indicated as an island or insular group in the Indian Ocean with a populace of Hindu culture. The phoenix, as shown by the above extract from Dāmīrī, is naturalized by the Arabs in India; and it is difficult to believe that the Adjaib should place the bird on Madagascar, in Indonesia, or in East Africa.

¹ G. WEIL, *Geschichte der Chalifen*, Vol. II, p. 253.

at the end, however, that the animal merely looks like a rat, but in reality is none, and that it occurs in the country of Gūr (east of Herāt in Khovaresm).¹ A gloss to the Talmud, which repeatedly alludes to the legends of the salamander, remarks that the animal has the shape of a mouse, and arises when the wood of the myrtle is burnt in a stove during seven consecutive years.² It is the same when other Oriental authors make the salamander an animal resembling a marten, except that it differs from it in color; for the salamander is always red, yellow, or green.³

THE SALAMANDER AND PHOENIX IN MEDIEVAL EUROPE.—In the poetry of the European middle ages the salamander appears first of all in the love-songs of the Provençal Troubadours. Pierre de Cols d'Aorlac regards the erotic fire burning in his heart as so pleasing that it is the more desirable to him, the more it burns him, like the salamander, which is happy in fire and blaze.⁴ In the contemporaneous lyrics of Italy we meet the allegories of the salamander and phoenix woven together: the amorous fire (*il foco amoroso*) is likened to that tenanted by the salamander; the poet is consumed by it, but at the same time rejuvenated like the phoenix; or he dies from the effect of the amorous fire like the phoenix, not being endowed with the salamander's property of being able to live in fire; or he rises again to a new life, like the phoenix, and life in fire becomes his second nature, as is the case with the salamander.

¹ F. HOMMEL, *Namen der Säugetiere bei den südsemitischen Völkern*, p. 338; JAYAKAR, *Damiri's Zoological Lexicon*, Vol. II, pt. I, p. 80. In another place Qazwini mentions also the mineral asbestos (G. JACOB, *Waren beim arabisch-nordischen Verkehr*, p. 18).

² L. LEWISOHN, *Zoologie des Talmuds*, p. 228.

³ D'HERBELOT, *Bibliothèque orientale*, Vol. III, p. 192.

⁴ The idea that the salamander is happiest in fire first occurs in Saint Augustin (*De civitate Dei*, XXI). It is notable how the exaggerations grow. Classical authors stated nothing to that effect, but merely that the salamander coming in contact with fire can extinguish it.

Also the German poetry of the thirteenth century not infrequently mentions the salamander, and incombustible materials spun from its hair. The latter, for instance, occurs in Wolfram von Eschenbach's *Parsifal*. The earliest mediæval allusion to this pseudo-salamander asbestos seems to be made in a Provençal treatise on birds and animals ("Naturas d'alcus auzels e d'alcunas bestias"), where it is said, "The salamander subsists on pure fire, and from its skin is made a cloth which fire cannot burn."¹ Again the salamander, through the metamorphosis of the phoenix, appears as a bird. Richard de Fournival, who died about 1260, regards the salamander as a white bird subsisting on fire, and from whose plumage are made cloths that can be purified only by fire.² According to the Old-French romance of Bauduin de Sebourg, the salamander lives in the terrestrial paradise as a bird with white woolly down made into tissues; and in Partonopeus de Blois a nuptial coat is lined with salamander's down.³ ALBERTUS MAGNUS (circa 1193—1280)⁴ seems to be the only mediæval author who knew that salamander's plume was asbestos.⁵ KONRAD VON MEGENBERG (1309—74), who in his *Book of Nature* devoted a chapter to the salamander,⁶ tells that Pope Alexander possessed a garment of salamander-wool which was washed in fire instead of water.

¹ Salamandra vieu de pur foc, e de son pel fa hom un drap que foc nol pot cremar. Compare F. LAUCHERT, *Geschichte des Physiologus*, pp. 186, 188, 189, 202.

² HIPPEAU, *Bestiaire d'amour*, p. 20 (Paris, 1860).

³ W. HERTZ, *Sage vom Giftmädchen*, p. 66 (*Abh. bayer. Akad.*, Vol. XX, 1893). He refers also to the Byzantine poet Manuel Philes (thirteenth century), who, in his didactic poem on the Properties of Animals, classifies the salamander among the birds.

⁴ *De secretis mulierum item de virtutibus herbarum lapidum et animalium*, p. 134 (Amstelodami, 1669).

⁵ Si vis ignem perpetuum inextinguibilem facere. Accipe lapidem qui Abaston dicitur, et est coloris ferrei et quam plurimum in Arabia reperitur. Si enim lapis ille accendatur nunquam poterit extinguere, eo quod habet naturam lanuginis, quae pluma salamandris vocatur, cum modico humidi unctuosi pinguis, inseparabilis est ab ipso, et id fovet ignem accensum in eo.—Albertus' form *abaston* may be compared with the Middle-English forms *asbeston*, *abeston*, *abiston*, *albeston*.

⁶ Ed. of F. PFEIFFER, pp. 276—279.

F. LAUCHERT¹ has shown that the mediæval notions of salamander and phoenix are traceable to the Greek Physiologus;² but he omitted to point out that the conception of the salamander-asbestos is novel, and peculiar to mediæval times. YULE³ admits that he cannot tell when the fable arose that asbestos was a substance derived from the salamander. Certain it is, that it did not exist among the classical peoples; certain it is, also, that the early mediæval writers, with the exception of Albertus Magnus, were not aware of the fact that the alleged product of the salamander was nothing but asbestos, and that asbestos as a mineral was unknown to them,⁴ while it was known to the Arabs. There can be no doubt that the Arabs (say, roughly, in the tenth and eleventh centuries) spread the legend to Europe⁵ by way of Byzance and Spain. The lacune indicated by Yule remains, and it will be seen in the further discussion that this gap in our knowledge is aptly filled by the records of the Chinese.

Marco Polo, with his keen power of observation and his large share of common sense, was the first to shatter the European superstition. It is interesting that he uses the word "salamander" in the sense of asbestos.

"In a mountain of the province of Chingintalas there is a vein of the substance from which salamander is made. For the real truth is that the salamander is no beast, as they allege in our part

¹ *Geschichte des Physiologus*, l. c.

² Plinian influence is visible in the venomous properties of the "snake salamander, which, when touching even the foot of a tree, poisons all its branches" (LAUCHERT, p. 194; PLINY, XXIX, 23).

³ In his edition of *Marco Polo*, Vol. I, p. 216.

⁴ MEGENBERG (*l. c.*, p. 434) noted asbestos after Isidorus, but did not see its identity with salamander-wool.

⁵ It is interesting to note that our own historians of the middle ages did not always grasp the facts in the case; while our Orientalists, owing to the knowledge of Arabic sources, were able to unravel the mystery. Thus A. SCHULTZ (*Das höfische Leben zur Zeit der Minnesänger*, Vol. I, p. 338) mentions without explanation "the textures produced from salamanders and burnt by no fire;" and G. JACOB (*Waren beim arabisch-nordischen Verkehr im Mittelalter*, p. 18), with reference to Qazwīnī, lays bare the fact.

of the world, but is a substance found in the earth; and I will tell you about it.

"Everybody must be aware that it can be no animal's nature to live in fire, seeing that every animal is composed of all the four elements. Now I, Marco Polo, had a Turkish acquaintance of the name of Zurficar, and he was a very clever fellow. And this Turk related to Messer Marco Polo how he had lived three years in that region on behalf of the Great Kaan, in order to procure those Salamanders for him. He said that the way they got them was by digging in that mountain till they found a certain vein. The substance of this vein was then taken and crushed, and when so treated it divides as it were into fibres of wool, which they set forth to dry. When dry, these fibres were pounded in a great copper mortar, and then washed, so as to remove all the earth and to leave only the fibres like fibres of wool. These were then spun, and made into napkins. When first made these napkins are not very white, but by putting them into the fire for a while they come out as white as snow. And so again whenever they become dirty they are bleached by being put in the fire.

"Now this, and nought else, is the truth about the Salamander, and the people of the country all say the same. Any other account of the matter is fabulous nonsense. And I may add that they have at Rome a napkin of this stuff, which the Grand Kaan sent to the Pope to make a wrapper for the Holy Sudarium of Jesus Christ." ¹

This sober account based on information received in China has left a lasting impression upon European science, and has taught how to discriminate between asbestos as a mineral and the salamander as an animal. A. BOETIUS DE BOOT ² rejected Polo's designation of

¹ Ed. of YULE and CORDIER, Vol. I, p. 213. It will be seen farther on that Marco Polo's account is confirmed by the contemporaneous Annals of the Yüan Dynasty.

² *Gemmarum et lapidum historia*, p. 383 (Lugduni Batavorum, 1636).

the mineral as salamander, restoring the ancient names "amiantus" and "asbestinus," and ridiculed the belief in any animal living in fire. Relying on Marco Polo, A. KIRCHER¹ has fully discussed the subject from a scientific point of view; and his contemporary, the zoölogist JOHN RAY,² was able to state, "Quod Salamandra sine ullo incommodo in igne vivere possit a vulgo creditum, verum a doctioribus dudum abunde refutatum est."

ASBESTOS IN THE NEAR EAST.—Asbestos was well known to the Arabs and Persians, and was much employed by them.³ A number of valuable notes concerning this matter we owe to the erudition of E. WIEDEMANN.⁴ Evliya Effenda narrates that the wonderful carpet presented by Khosru I Nürshirvān to the monastery which he built near Ütch Kilise was made of asbestos, and that asbestos textiles were manufactured on Cyprus.⁵ The Arabic soldiers who hurled naphtha at beleaguered towns were equipped with asbestos garments in order to guard them from accidents which might have happened from handling this inflammable substance.⁶ Dimashqī, Abul Fedā (1273—1331), and Yāqūt (1179—1229) point to Badakshān

¹ *La Chine illustrée*, pp. 278—280 (Amsterdam, 1670). Kircher says that he could receive no information as to the stuff sent by the Great Khan to the Pope (see also CORDIER's note in Yule's *Marco Polo*, Vol. I, p. 216; and compare the above quotation from K. von Megenberg).

² JOANNES RAIUS, *Synopsis animalium quadrupedum*, p. 273 (Londini, 1693).

³ A Syriac allusion occurs in the *Historia Monastica* of the Bishop of Margā (A.D. 840): "Prayer made the martyrs like asbestos before the fire" (E. A. W. BUDGE, *The Book of Governors*, Vol. II, p. 499).

⁴ *Zur Mechanik und Technik bei den Arabern* (SB. P. M. S. Erlg., Vol. 38, 1906, pp. 39, 40).

⁵ The latter notice goes back to Dioscorides (L. LECLERC, *Traité des simples*, Vol. II, p. 414).

⁶ The Italian chevalier Aldini, about 1825, conducted a series of experiments in using asbestos garments for the protection of firemen. His idea was revived in Paris, the firemen there having been furnished with such clothes, and after conclusive proof of their practical utility, was followed in London (R. H. JONES, *Asbestos*, pp. 31, 159).

as the place where the mineral was found; the former making special mention of lamp-wicks made from it, into which fire penetrates, while they remain unharmed. Yāqūt has the following report: "In the mines near Badakshān is found the stone *fatīla* (that is, 'stone of the wick'), which resembles papyrus (*bardī*). The people believe that it is the plumage of a bird.¹ It is styled also *al-ṭalq*. It is not consumed by fire. It is placed in oil and kindled with fire, in which case it burns like a lamp-wick.² When the oil burns, the stone remains as before, and none of its properties changes. This always takes place whenever it is dipped in oil and burns. When thrown into a blazing fire, it is not hurt by it. Coarse table-cloths are woven from it. These, being soiled, are put into fire to be purified, and whatever dirt is on them is consumed by the flames. They are cleansed, and come out as pure as though they had never been affected by dirt." The erroneous designation *al-ṭalq* is traceable to Ibn al-Baiṭār (1197—1248), who groups around Dioscorides' notice of asbestos Arabic accounts of the mineral *ṭalq* corresponding to our mica.³

A very interesting description of asbestos is given by Abū Ubaid al-Bekrī (1040—94) of Cordova in Spain, in his *Geography of Northern Africa*, as follows:⁴—

"Among the singular products of the country of the Negroes is noticeable a tree with long and slender stem, called *turzi*. It grows in the sand, and bears a big and swollen fruit containing within it a white wool which is made into stuffs and garments. These stuffs are capable of remaining in a vehement fire forever without

¹ That is, the phoenix. For explanation see above, pp. 318—323.

² Compare the statement of Theophrastus (p. 302).

³ L. LECLERC, *Traité des simples*, Vol. II, pp. 414, 415. Pseudo-Aristotle (RUSKA, *Steinbuch des Aristoteles*, p. 174) also describes mica under the same name.

⁴ MACGUCKIN DE SLANF, *Description de l'Afrique septentrionale par El-Bekri*, p. 336 (Alger, 1913).

being damaged. The jurist Abd al-Melek affirms that the inhabitants of Al-Lames, a town of that region, wear only clothing of this kind. Near the river Derā is found a substance similar to it. This is a sort of stone, called, in the language of the Berber, *tamatghost*. When rubbed between the hands, it softens to such a degree that it assumes the consistency of linen. It serves for the making of cordage and halters, which are absolutely incombustible. A costume was made from this substance for one of the Zenatian princes who ruled at Sidjilmessā. A man of proved veracity told me that a trader had sent for a napkin made from this mineral for Ferdilend, King of Galicia, in Spain (Ferdinand I of Leon). He offered it to the prince, explaining that it had belonged to one of the disciples of Jesus, and that fire could produce no impression upon it. He furnished the proof under the eyes of the King, who, struck by such a marvel, expended all his wealth to purchase this relic. He sent it to the sovereign of Constantinople, that it might be deposited in the principal church, and in return received a royal crown with the authorization to wear it. Several persons tell of having seen in the house of Abul Fadl of Bagdad the fringe of a napkin made of this substance, which, when put into fire, became whiter than previously. In order to clean such a napkin, which had the appearance of linen, it was sufficient to place it on a fire."

The employment of asbestos for the purpose of a *pia fraus* is related also by an Arabic traveller. Abū Dulaf who wrote the diary of his journey to China about 941 tells of an incombustible tree, growing in the territory of the tribe Bajā (east of Transoxania), from the wood of which the natives make idols; Christian travellers are in the habit of taking this wood along, asserting that it comes from the cross of Christ. Again he relates about the tribe Kharlok that their houses are of incombustible wood.¹ Both Marquart and

¹ G. FERRAND, *Relations de voyages arabes, persans et turks rel. à l'Extrême-Orient*,

Ferrand who translated and discussed this text have been unable to cope with this problem. Certainly it is not here the question of a tree, as wrongly supposed by these scholars; still less do we meet here, as suggested by Marquart, the conception that the wood of the cross had miraculously been shooting forth again. What we meet here, in fact is asbestos; and this matter has clearly been expounded as early as 1843 by J. YATES in his classical work *Textrinum Antiquorum: An Account of the Art of Weaving among the Ancients* (pp. 362—365). Yates sets forth that ignorance of the true nature of asbestos caused it to be employed in the dark ages for purposes of superstition and religious fraud, and cites several important documents to this effect. One of these is taken from the *Chronicon Casinense* ("Chronicle of the Abbey of Monte Casino") of Leo Ostiensis who narrates a story that some monks returning from a pilgrimage to Jerusalem brought home a particle of the cloth with which Jesus wiped the feet of his disciples (*particulam lintei, cum quo pedes discipulorum Salvator extersit*); and when the genuineness of this relic was doubted, they put it in fire from which it came forth in its previous shape. Thus the authenticity of the relic was convincingly established. Tilingius, in 1684, directly says that impostors exhibit to simple women-folks the stone amiantus, and frequently sell it as

Vol. I, pp. 210, 215. Ferrand has misunderstood Marquart, for he ascribes to the latter the supposition that the question is here of teak-wood. On the contrary, MARQUART (*Osteurop. und ostasiat. Streifzüge*, p. 76) has decidedly rejected this idea, and strangely enough proposed to regard the incombustible tree as the birch. Why the birch should be called incombustible I am unable to see. Abū Dulaf is not to be taken too seriously in matters of natural history; and his assigning to certain tribes of certain products, as partially seen also by Marquart, is purely arbitrary or fictitious. The list of his stones presents curious reminiscences of the fabulous stones of the Alexander Romance and the Arabic *lapidaires* based thereon. The most striking of these reminiscences is the stone luminous at night and serving as lamp (*Pseudo-Callisthenes*, II, 42). This stone, according to the Arabic scribe, is found in the country of the Kirgiz! For this reason I am inclined to think that also his incombustible tree is a purely literary invention from the same source. The Chinese have several accounts of unconsumable trees, partly leaning toward asbestos (see WYLIE, *l. c.*, p. 148).

the wood from the cross of the Savior; they easily take faith therein, since it is not consumed by fire and is veined in the manner of wood. It is equally manifest that Abū Dulaf's incombustible tree which supplied Christians with sacred souvenirs of the cross was nothing but asbestos, and the report of al-Bekri previously mentioned affords additional evidence to this effect. The alleged products ascribed by Abū Dulaf to Central-Asiatic regions are fancifully construed from the legends told in the Alexander Romance, and there, as mentioned above (p. 308), we encounter also the asbestine wood.

Under the Sung dynasty asbestine stuffs were imported into China by the Arabs over the maritime route; they were seven inches wide, differing in length. In the period Chêng-ho 政和 (1111—18), under the Emperor Hui-tsung, asbestine stuffs of half this width were sent as tribute by the Arabs, and at a later date were followed by dishes and baskets of the same material, which on the whole looked like the cloth then made from the product of the cotton-tree, but somewhat darker and almost black in color. When flung into the fire, they came forth brilliant white.¹ Mosul produced asbestine cloth during the middle ages.²

THE SALAMANDER-ASBESTOS IN CHINA.—After this review of the development of the relevant beliefs in the West, we are prepared to understand the asbestos traditions of the Chinese. In these, three stages of development are clearly set off. The first, already described, ranging approximately from the Han to the third century, I am tempted to term the "historical or classical" set of beliefs,

¹ We shall revert once more to this text, not utilized by Wylie and inserted in the *T'ie wei shan ts'ung t'an* 鐵圍山叢談 (Ch. 5, p. 20; edition of *Chi pu tsu chai ts'ung shu*) of Ts'ai T'iao 蔡條, who lived in the first half of the twelfth century. WYLIE (*Notes*, p. 196) states regarding this author that he treats mostly of events which occurred in his own time, and that the work shows a good deal of research, and may be relied upon as an authority in investigations regarding that period.

² HIRTH and ROCKHILL, *Chau Ju-kua*, p. 140.

agreeing, as they do, with Greek and Roman lore; the second, from the beginning of the fourth century down to the end of the Sung, denotes the "romantic" period of beliefs, coinciding with those of mediæval Europe and the Arabs; the third, inaugurated by the Yüan or Mongol dynasty, is the "realistic," or, if the word be allowed, "scientific," period, based on the actual discovery of asbestos on Chinese soil. We have to deal here first with the mediæval romanticism inaugurated by the speculations of the adepts of Taoism.

The earliest attempts to explain the origin and composition of asbestos were made by the celebrated alchemist Ko Hung 葛洪 (249—330), in his work *Pao-p'u-tse*.¹ This author reports on three kinds of asbestos (*huo huan pu* 火浣布) as follows: "As regards the first kind of fire-proof cloth, it is said that there is in the ocean a majestic mound² harboring a fire that burns of itself.³ This fire rises in the spring, and becomes extinguished in the autumn. On this island grows a tree, the wood of which is able to resist the action of fire, and is but slightly scorched by it, assuming a yellow color. The inhabitants make fuel of it in the usual way, but this fuel is not transformed into ashes. When their food has been cooked, they extinguish the firewood by means of water. In the same manner it is put to use again and again, and indeed represents an inexhaustible supply. The barbarians gather the flowers

¹ My rendering is based on the text as quoted in the *Wei lio* 緯畧 (Ch. 4, p. 3; ed. of *Shou shan ko ts'ung shu*, Vol. 74). This fundamental source on the subject has been overlooked by Wylie.

² *Su k'iu* 肅邱. I should be inclined to regard this as the proper name of Volcano Island, if this term were traceable in the Liang Annals, which, as will be seen below, contain the source for this account of Ko Hung; but it does not occur there. Again, the notice of the Annals goes back to the lost reports of K'ang T'ai 康泰, on his mission to Fu-nan in the first part of the third century. If K'ang T'ai's report had contained the name *Su k'iu*, we might reasonably conclude that it would have found its way into the Annals; for this reason it may be solely an invention of Ko Hung.

³ That is, an active volcano.

of these trees, and weave cloth from them. This is the first kind of fire-proof cloth. Further, they also peel the bark of these trees, boil it by means of lime, and work it into cloth, which is coarse and does not come up to the quality of the material prepared from the flowers. This is the second kind of fire-proof cloth. Moreover, there are white rodents (*pai shu* 白鼠) covered with hair, each three inches long, and living in hollow trees. They may enter fire without being burnt, and their hair can be woven into cloth, which is the third kind of fire-proof cloth.”¹

The first two sorts of asbestos established by Ko Hung, and alleged to be of vegetal origin, are certainly imaginary; and how this matter came about will be fully discussed hereafter. Here the fact that concerns us is that Ko Hung is the first Chinese writer in whom the idea of the animal origin of asbestos has crystallized. Certainly, his “white rodent” is nothing but the salamander of the Western legend, whose wool furnishes asbestos. At first sight it is striking, of course, that Ko Hung’s notice far precedes in time any Western version of the legend; yet this can rationally be explained. Two conjectures which might be made to get easily over this state of affairs would not prove before the facts. We cannot assume that the legend is spontaneously Chinese in origin and migrated from China to Western Asia: in China it has no basic facts, whereas

· 抱朴子曰。火浣布有三種。其一曰海中肅邱有自生火。春起秋滅。洲上生木。木爲火焚不糜但小 (gloss: 一無小字) 焦黃。人或得薪俱如常。薪但不成灰。炊熟則以水滅之。使復更用如此不窮。夷人取此木華績以爲布一也。又其木皮赤剝之。以灰煮治以爲布。麓不及華俱可火浣二也。又有白鼠毛長三寸居空木中。入火不灼。其毛可績爲布三也 (Wei lio, Ch. 4, p. 3).

we have traced its logical development in the West from the combination of salamander and asbestos. Nor would it be possible to regard the account of Ko Hung as unauthentic or as an anachronism, as we have a number of texts, ranging from the fourth to the sixth century, all relating to the same legend. The *Wu lu* 吳錄¹ is credited with the statement that in Ji-nan (Tonking) is captured a fire-rodent whose hair is made into cloth, being styled "fire-proof cloth."² According to BRETSCHNEIDER,³ this book was written in the third century, during the period of the Three Kingdoms (221—280); but it is hard to believe that at that early date the legend of the salamander-asbestos was known in China. The localization in Ji-nan, foreign to Ko Hung, also seems somewhat suspicious. We have noticed above (p. 312) that asbestos was known in the China of that period, and that in the coeval Annals a tribute gift of it from the Western Regions (*Si Yü*) is on record for the year 239, no reference, however, being made to the salamander story. The earliest date that we may assume for the coming into existence of the latter on Chinese soil is the end of the third or the beginning of the fourth century.

It is more interesting that Kuo P'ö 郭璞 (276—324), a contemporary of Ko Hung, likewise alludes to the salamander-asbestos; for Kuo P'ö, in his commentary to the *Shan hai king*, is made to say the following, as translated by WYLIE:⁴ "Ten thousand *li* to the east of Fu-nan is the kingdom of Ké-po. More than five thousand *li* farther east is the burning mountain kingdom, where, although there may be long-continued rain on the mountain, the

¹ Records of the Kingdom of Wu, by Chang Pu 張勃 of the third century.

² *Wei liö*, Ch. 4, p. 3. WYLIE (*l. c.*, p. 149) quotes this passage from *T'ai p'ing yü lan* (Ch. 820, p. 8), where the locality is defined as Pei-king 北景 in Ji-nan.

³ *Bot. Sin.*, pt. 1, p. 209, No. 1043.

⁴ *L. c.*, p. 146.

fire constantly burns. There is a white rat in the fire, which sometimes comes out to the side of the mountain, in order to seek food, when the people catch it and make cloth from the hair, which is what is now called fire-proof cloth." What Wylie transcribes Ké-po is properly Ch'í-po 耆薄; and this is nothing but a variant for the well-known Shê-p'ó 閩婆, the old Chinese designation for the island of Java. The fact that in this connection the question really is of Java becomes evident from other parallel texts alluding to the same matter.¹ The name "Shê-p'ó" for Java, however, does not appear in Chinese records earlier than the first half of the fifth century, the first embassy coming from there being listed in the year 433: consequently Kuo P'ó of the Tsin dynasty cannot have possessed any knowledge of Shê-p'ó, which name must be a later interpolation in his text. Aside from this point, however, the story is entirely creditable to him, because the geographical portion of it, as will be seen, is based on the narrative of K'ang T'ai of the third century, and is even more exactly reproduced by him than by Ko Hung. Kuo P'ó, however, shuns the account of vegetable asbestos, as related by K'ang T'ai and repeated after him by Ko Hung, and focusses the notion of asbestos exclusively on the white rodent (that is, the salamander) inhabiting an active volcano. K'ang T'ai knew nothing at all about this animal. Ko Hung does not naturalize it anywhere. It is Kuo P'ó who took up this legend and placed its home on the Volcano Island first reported by K'ang T'ai: consequently Kuo P'ó's story is a compromise reached between the salamander story coming from the West and the tree-asbestos story of Fu-nan, but it is valueless for tracing the region from which the salamander legend hailed. It did not hail from Volcano

¹ Compare PELLLOT, *Bull. de l'Ecole française*, Vol. III, p. 264; Vol. IV, p. 270; these texts will be discussed farther on.

Island in the Malay Archipelago, as K'ang T'ai located there only the alleged tree-asbestos, which in fact is bark-cloth, that has nothing to do with mineral asbestos. K'uo P'o, further, shows his familiarity with the salamander in his edition of the dictionary *Erh ya*.¹ This enumerates ten kinds of tortoise, the tenth of which is termed "fire tortoise" (*huo kwei* 火龜); and K'uo P'o annotates that it is like the "fire rodent" (*huo shu*).² The latter animal is not included among those enumerated in the text of the *Erh ya*; that is to say, it is entirely foreign to the ideas of ancient national Chinese culture, but is a borrowed type, which first dawned upon the horizon of the Chinese in the very age of K'uo P'o himself.

Another contemporaneous allusion to the same matter is found in the *Ku kin chu* 古今注, written toward the middle of the fourth century by Ts'uei Pao 崔豹, who says that the fire-rodent remains immune when going into fire, and that what is termed "fire-proof cloth" is made from the animal's hair, which is ten feet long.³ Ts'uei Pao, in his succinct and sober statement, thoroughly agrees with Ko Hung, differing from him only in somewhat exaggerating the length of the hair. Yet the same author, in the same work, presents a more fantastic account of the matter, which he traces to the *Book of Marvels*⁴ ascribed to the Taoist adept Tung-fang So (born in 160 B.C.). This attribution, as is well known, certainly is fictitious; and the following text bears out this fact again, because it is based on the account of K'ang T'ai, and must therefore be later than the third century. Tung-fang So, according

¹ Ch. B, p. 10 b.

² This name has been adopted by the Polyglot Dictionary of K'ien-lung (Ch. 31, p. 24) with the literal renderings into Manchu *tuwai singgeri*, Tibetan *me byi*, and Mongol *galxi khulugana*. The explanations given in the Manchu dictionaries show that the salamander-asbestos is understood (see SACHAROV, *Manchu-Russian Dictionary*, p. 765).

³ *P'ei wen yün fu*, Ch. 36, p. 59.

⁴ Entitled by him *Shen i chuan* 神異傳, otherwise *Shen i king* 神異經.

to Ts'uei Pao, is made to say,¹ "In the southern regions there is a volcano forty *li* in length, and from four to five *li* in width. In the midst of this volcanic fire grow trees unconsumable by fire, and day and night exposed to a scorching heat, over which neither wind nor rain has any power. In the fire lives also a rodent, a hundred catties in weight, and covered with hair over two feet in length, as fine as silk, and white in color."² Sometimes it comes out; and by sprinkling water over it, it is put to death. Its hair is then removed and woven into cloth, which is known under the name 'fire-proof cloth.'" Another text, likewise wrongly connected with the name of Tung-fang So, expatiates on the animal with still greater vagaries of fancy, and will be discussed below. We notice that in this Taoist narrative the salamander is made a denizen of Volcano Island, in the same manner as by Kuo P'ao. We accordingly have two versions of the legend current during the fourth century,—a simple and sober one, accounting for the origin of asbestos from an animal identical with the Western salamander; and an elaborate and fantastic one, aggrandized by Taoist lore under the influence of K'ang T'ai's report of a Volcano Island in the Malay Archipelago.

The salamander turns up again in that interesting book *Liang se kung tse ki*, relating to the beginning of the sixth century, and written by Chang Yüe (667—730),³ "Merchants from the Southern

¹ *Pien tse lei pien*, Ch. 21, p. 6. The text is quoted also in the commentary to *San kuo chi*, *Wei chi* (Ch. 4, p. 1 b), in the *Wei lio* (Ch. 4, p. 3), and in the *Ts'i tung ye yü* by Chou Mi.

² It must certainly be white, because asbestos coming out of a fire has this color. WYLIE (*l. c.*, p. 145), who translates from a modern edition of *Shen i king*, has the addition, "It ordinarily lives in the fire, and is of a deep-red color; but sometimes it comes out, and its hair is then white."

³ See this volume, p. 198. The text in question is preserved in the *Wei lio* 緯畧, Ch. 4, p. 3 b; and in the *Ko chi king yüan*, Ch. 27, p. 13. WYLIE (*l. c.*, p. 143) seems to have translated from another book. His addition, "which the emperor had deposited among the miscellaneous cloths," is not in the text before me.

Sea brought as presents three pieces (*luan*)¹ of fire-proof cloth.² Duke Kie, recognizing it from afar, exclaimed, 'This is fire-proof cloth, indeed: Two pieces are made from twisted bark,³ and one is made from the hair of a rodent.' On making inquiry of the merchants, their statement exactly agreed with that of the duke.⁴ On asking him the difference between the cloth of vegetal and that of animal origin, the duke replied, 'That manufactured from trees is stiff, that from rodents' hair is pliable; this is the point by which to discriminate between them. Take a burning-mirror and ignite the *tsé* trees⁵ on the northern side of a hill, and the bark of the trees will soon become changed.' The experiment was made, and it turned out in accordance with his affirmation."⁶ The witty duke, accordingly, exploded the old tale of K'ang T'ai, that bark cloth was incombustible and a sort of asbestos. He himself, on former occasions, had doubtless applied the experiment which he recommended in the course of the story, and was possessed of that truly scientific

¹ A cloth measure of 18 feet.

² According to the text of the *Wei lio*, "Duke Kie, passing a market, noticed traders offering three *luan* of fire-proof cloth" (杰公至市見商人齎火浣三端).

³ It is notable that he speaks of twisted, not of woven bark, as K'ang T'ai and his followers did (see p. 347).

⁴ This sentence is omitted in the text of the *Wei lio*.

⁵ 柘木 *Cudrania tribola*, Hance. Wylie takes this for 斫, or he may have found this reading in his text; for he translates, "Take some wood cut down on the north side of the hill and set a light to it by means of a solar speculum." Duke Kie, of course, did not mean to say this. He wanted to prove by experiment that tree-bark is not incombustible, like asbestos; and with this end in view, it was not necessary to chop the trees.

• 南海商人齎火浣布三端。杰公遙識曰。此火浣布也。二是緝木皮所作。一是績鼠皮所作。以詰商人具如杰公之說。因問木鼠之異。公曰。木堅毛柔是可別也。以陽燄火山陰柘木蕪之木皮改。常試之果驗 (*Ko chi king yüan*, Ch. 27, p. 13).

spirit which does not halt at received traditions, but tries by experiment to get at the root of things. To him true asbestos was only the kind attributed to the salamander,¹ and the duke's wisdom demonstrates that the rodents' hair of the Chinese was really mineral asbestos.

The texts thus arrayed bear out sufficiently the fact that the legend of the salamander-asbestos was popularly current in China from the fourth to the sixth century; and the records of the Chinese very aptly fill the gap which, as we noticed (p. 325), exists in the West between the close of classical antiquity and the traditions of the Arabs and mediæval Europe. The Chinese texts are all prior to those of the Arabs, and it is therefore necessary to conclude that the Chinese and the Arabs must have borrowed the legend from a common source extant in Western Asia at least during the third century. This source is as yet unknown to us, but the conviction of its existence is a postulate without which we cannot intelligently understand the case. There are also indications in Western sources which allow the inference that this prototype resulting in the Chinese and Arabic notions must have lingered in the anterior Orient in the beginning of our era. We have referred to the probable Oriental origin of the salamander legend, and to Pliny's association of it with the Persian Magi; we have pointed out also that it was current in Egypt during the first century A.D., and that Pliny's and Aelian's stories are dependent on the Alexandrian Physiologus. There is accordingly good reason to believe that the

¹ This is confirmed by another passage in the same work *Liang se kung tse ki*, in which Volcano Island (火洲) is mentioned. Here it is said that from the bark of the fiery tree growing there only cloth is made, while fire-proof cloth is produced from the hair of the fire-rodent living on a blazing mound. This text will be found in *T'u shu tsi ch'êng*, *Pien i tien* 41, Woman Kingdom (*Nü kuo*), *hui k'ao*, p. 2. It is said to have been translated in its entirety by D'HERVEY-ST.-DENYS in his *Mémoire sur le Fou-sang*, which unfortunately is not accessible to me.

salamander legend was known in the Orient on a line stretching from Egypt to Persia, and that the numerous translations of the Physiologus, if nothing else, supported its wide diffusion. At the same time, however, as we know from the Chinese records, asbestos-cloth was in evidence in western Asia, and was traded from there over the routes of Central Asia to China. Salamander and asbestos being familiar to the nations of the Roman Orient, they were in possession of the elements with which to form that legend which proceeded from them to China and at a later date loomed up among the Arabs. It may be supposed that this primeval version, as yet unknown, will turn up some day in an early Syriac source (or possibly in a Greek papyrus): and if a Syriac work should tell us of an asbestos-tree, and immediately join to this a notice of the salamander,¹ we may imagine that the temptation was strong to link those two accounts together.

The germ of this lost Oriental version possibly is traceable to a Greek text, from which it can be shown how the identification of asbestos with the salamander may have been effected. Antigonus of Carystus, who was born between 295 B.C. and 290 B.C., and lived at Athens and Pergamum,² has left a small collection of "Wonderful Stories," among which is the following:³ "There are worm-shaped hairy creatures living in the snow. In Cyprus, where copper-ore is smelted, an animal is engendered a little larger than a fly. The same occurs also in the smelting-furnaces of Carystus. Part of them die when separated from the snow; others, when separated from the fire. The salamander, however, quenches the fire." This text is based on that of Aristotle, given above (p. 314), where

¹ See above, p. 308.

² Compare U. VON WILAMOWITZ-MÖLLENDORFF, *Ueber Antigonos von Karystos*.

³ *Historiae mirabiles*, 90, 91 (*Rerum naturalium scriptores Graeci minores*, ed. KELLER, Vol. I, p. 22).

are also mentioned worms found in long-lying snow.¹ Antigonus, however, has here an essential addition, not met with in Aristotle or any other author; and this is that this fire animal occurs also in the furnaces of Carystus.² Now, we have seen that, according to Apollonius and Strabo, Carystus on Euboea was one of the principal asbestos-producing regions, and that from this locality the mineral was even named Carystius. Antigonus hailed from Carystus, and this fact may entitle us to the opinion that he was acquainted with the asbestos mined near his home town. True it is, he does not mention asbestos in the few fragments of his writings which are preserved; and there is nothing to indicate that in the above passage he means to include asbestos in the "smelting-furnaces of Carystus." The point which I wish to make, however, is that it was easy to read this interpretation into his text. An Oriental Greek, Syrian, or Arab, for instance, who knew that "Carystius" was a synonyme for "asbestos," could well have been reminded thereof while reading this passage, and the immediate mention of the salamander might then have led him to link the two notions together.³ In this manner we gain a satisfactory clew as to the probable origin of the salamander-asbestos assimilation, which certainly must have been brought about on the soil of Hellenism,

¹ Aristotle does not name the animal living in fire, but, judging from his description, it appears to be an insect. PLINY (XI, 36, § 119), who speaks of the same creature after Aristotle, calls it *pyrallis* or *pyrotocon* (others read *pyrausta*), and describes it as a winged quadruped (*pinnatum quadrupes*) of the size of a larger fly. AELIAN (*Hist. anim.*, II, 2) styles it *pyrighos* ("fire-born").

² Pliny, in harmony with Aristotle, places it only on Cyprus (*in Cypri aerariis fornacibus*), while Aelian gives no locality.

³ It is possible also that the *μυῖον* of the Greek text (from *μύις*, "fly") led to a confusion with *μῦς* ("mouse"), and gave rise to the conception of the salamander as a rat (Qazwīnī), mouse (Talmud), or rodent (Chinese). On the other hand, it must be admitted that this metamorphosis is capable also of a logical explanation: the salamander-lizard is smooth and hairless; when the salamander was made to yield asbestos, it naturally had to be transformed into an animal with hair-growth.

during the second or in the beginning of the third century A.D.

Besides the salamander of the character of a rodent, we receive another intimation as to the nature of this animal, which answers the classical notions. A work *Sung chi* 宋志 ("Memoirs of the Sung Period"), by Shên Yo 沈約,¹ contains the following notice: "Blazing Island (Yen chou 炎洲) is situated in the southern ocean, and harbors the animal *ki* (or *kîe*)-ku 狓狓. When it is caught by people, it cannot be wounded by chopping or piercing. They gather fuel, build a fire, bind the animal and throw it into the fire, and yet it will remain unscorched."²

The name for this animal, which is clearly differentiated from the rodent that follows, seems to be connected with some Malayan form underlying our word "gecko," described thus by YULE and BURNELL:³ "A kind of house-lizard. The word is not now in Anglo-Indian use; it is a naturalist's word; and also is French. It was no doubt originally an onomatopœia from the creature's reiterated utterance. Marcel Devic says the word is adopted from Malay *gekok* [*gēkoq*]. This we do not find in Crawfurd, who has *tāké*, *tākék*, and *goké*, all evidently attempts to represent the utterance. In Burma, the same, or a kindred lizard, is called *tokté*, in like imitation."⁴

¹ Quoted in *Ye k'o ts'ung shu* 野客叢書 by Wang Mou 王懋 of the Sung period (*Ko chi king yüan*, Ch. 27, p. 13). Regarding this work see WYLIE, *Notes on Chinese Literature*, p. 161. It was published in 1201.

² Then follows the story of the rodent-salamander mingled with the alleged bark-cloth asbestos: "There is, further, the Volcanic Country, constantly enveloped by fire which is not quenched by rain. In this fire there is a white rodent. When the trees in the forests on this burning island have been wetted by rain, their bark becomes scorched; and when exposed to fire, it becomes white. The islanders gather this bark during several months, and weave it into cloth, which makes fire-proof cloth. Either the bark of the trees or the hair of the rodents may yield it."

³ *Hobson-Jobson*, p. 367.

⁴ "Some of the Borneo reptiles produce singular sounds. The commonest among them is a gecko, the *chichak*, which name imitates perfectly the cry which it produces. A much louder and more characteristic cry is that of *Goniocephalus borneensis*, a large

The characters *ki-ku*, in this case, are chosen by the Chinese author only to imitate the sounds of a word like "gecko." As a rule, the animal *ki-ku* is regarded as a mammal. The word first appears under the T'ang in the *Yu yang tsa tsu*, and is synonymous with *fêng li* 風狸, *fêng mu* 風母 ("wind mother"), or *fêng shêng shou* 風生獸 ("wind-born beast").¹ On the other hand, the Chinese know a saurian, *ko-kiai* 蛤蚧, being a word-formation analogous to the Malayan names of the lizard, and, according to Chinese authors, imitative of the call of the animal.²

It thus appears that the rodent-salamander of the Chinese, after all, was a lizard like the salamander of the ancients; and the lizard character of the animal leaks out in the earliest account of the subject by Ko Hung, when he says that the animal lives in hollow trees; for it is the lizard who has acquired this habit. A. R. WALLACE,³ in describing the lizards of the Aru Islands, observed, "Every shrub and herbaceous plant was alive with them; every rotten trunk or dead branch served as a station for some of these active little insect-hunters."

The fact that it was not the Arabs from whom the Chinese received the salamander-asbestos tale is illustrated, from a negative

lizard which lives on trees and has a high and serrated crest down its back. The Malays call this lizard *kog-go*, an imitation of its call-note, which is frequently repeated" (O. BECCARI, *Wanderings in the Great Forests of Borneo*, p. 35). In the *Encyclopædie van Nederlandsch-Indië* (Vol. IV, p. 400) the word is given as *toke*, which is peculiar to Sundanese; it passed also into the language of the Batak on Sumatra; in Malayan it is *tekek* and *tokek*; in Javanese, *tekek*. Compare Moro *tagatak* or *tukatuk*, "lizard" (R. S. PORTER, *Primer of the Moro Dialect*, p. 45). In the same encyclopædia (Vol. I, p. 551) will be found a description of the genus and of the beliefs in its venomous property, which are very similar to those entertained by the ancients in regard to the salamander.

¹ See the texts of *Pên ts'ao kang mu*, Ch. 51 A, p. 20 b; and *Wu li siao shi*, Ch. 10, p. 12.

² *Pên ts'ao kang mu*, Ch. 43, p. 6. The oldest text referring to it is the *Ling piao lu i* of the T'ang (compare PRIZMAIER, *Denkwürdigkeiten aus dem Tierreiche Chinas*, *SBAk. Wien*, Vol. 80, 1875, p. 14).

³ *The Malay Archipelago*, p. 331.

viewpoint, by the absence in China of any specific reference to the phoenix, of which the Arabs make a great case (p. 319). Some Chinese works have a general reference to birds, but the coincidence is not perfect. Thus the apocryphal *Sou shên ki* 搜神記¹ has a volcano in the region of the K'un-lun, inhabited by herbs, trees, birds, and mammals, all existing in blazing fire and yielding fire-proof cloth.²

¹ WYLIE, *Notes*, p. 192. The passage is in Ch. 13, p. 3 (of the Wu-ch'ang print).

² A case of a different character may be mentioned in this place, as it reveals a very curious coincidence between a Chinese and an Arabic text. The interesting work *Tu yang tsa pien* 杜陽雜編, written by Su Ngo 蘇鶚 in the latter part of the ninth century, contains the following story (Ch. B, p. 1; edition of *Pai hai*): "During the year of the reign of the Emperor Shun-tsung 順宗 (A.D. 805) the country Kiü-mi 拘弭 [otherwise 拘彌, the territory of Keria; see CHAVANNES, *Documents sur les Tou-kiue occidentaux*, p. 128] sent as tribute a pair of birds insensible of fire (劫火雀一雄一雌). These birds were uniformly black and of the size of a swallow. Their voice was clear, but did not quite resemble that of ordinary birds. When placed on a fire, the fire was spontaneously extinguished. The Emperor, admiring this wonder, had the birds put in a cage of rock-crystal [rock-crystal being believed to be a transformation of ice and to have a cooling effect], which was hung in the sleeping-apartments of the palace. At night the inmates of the palace tried to set fire to the birds by means of burning wax candles, but entirely failed in damaging their plumage." Abu Ubaid al-Bekrî (1040—94) of Cordova (MAC GUCKIN DE SLANE, *Description de l'Afrique septentrionale par El-Bekri*, p. 43) has the following account: "Nous donnons le récit suivant sur l'autorité d'Abou-'l-Fadl Djäfer ibn Yousof, Arabe de la tribu de Kelb, qui avait rempli les fonctions de secrétaire auprès de Mounis, seigneur de l'Ifrikiya: 'Nous assistions à un repas donné par Ibn-Ouanemmou le Sanhadjien, seigneur de la ville de Cables, quand plusieurs campagnards vinrent lui présenter un oiseau de la taille d'un pigeon, mais d'une couleur et d'une forme très singulières. Ils déclarèrent n'avoir jamais vu un oiseau semblable. Le plumage de cet animal offrait les couleurs les plus belles; son bec était long et rouge. Ibn-Ouanemmou demanda aux Arabes, aux Berbers et aux autres personnes présentes s'ils avaient jamais vu un oiseau de cette espèce, et sur leur réponse qu'ils ne le connaissaient pas même de nom, il donna l'ordre de lui couper les ailes et de le lâcher dans le palais. A l'entrée de la nuit, on plaça dans la salle un brasier-fanal allumé, et voilà que l'oiseau se dirigea vers ce meuble et tâcha d'y monter. Les domestiques eurent beau le repousser, il ne cessa d'y revenir. Ibn-Ouanemmou, en ayant été averti, se leva, ainsi que toute la compagnie, afin d'aller voir ce phénomène. Moi-même, dit Djäfer, j'étais un de ceux qui s'y rendirent. Alors, sur l'ordre d'Ibn-Ouanemmou, on laissa agir l'oiseau, qui monta jusqu'au brasier ardent, et se mit à becqueter ses plumes, ainsi que font tous les oiseaux quand ils se chauffent au soleil. On jeta alors dans le brasier des chiffons imprégnés de goudron et une quantité d'autres

While the Chinese, in a somewhat masqueraded form, received the legend of the salamander, they never adopted this word, as did the Arabs and Persians. It was reserved for the Jesuit Father Ferdinand Verbiest (1623—88) to introduce the Chinese, in his *Kun yü t'ü shuo*, to an illustration of a European salamander under the title *sa-la-man-ta-la* 撒辣漫大辣, which he says occurs in the country Germania (*Je-êrh-ma-ni-ya*) in Europe: "Its habitat is in cold and moist places, its temper is very cold, its skin is thick, and its strength is such as to extinguish fire; its hair is of mixed color, black and yellow; a black and spotted crest runs along its back down to its tail." The figure by which his note is illustrated shows a cat or fox-like mammal.¹

THEORY OF THE VEGETAL ORIGIN OF ASBESTOS.—In order to arrive at a correct appreciation of the complex notions developed by Ko Hung and Kuo P'ö regarding asbestos, we shall now turn our attention to another matter. In the first half of the third century A.D., K'ang T'ai 康泰 and Chu Ying 朱應 were engaged in a mission to Fu-nan 扶南 (Cambodja), and on their return to China published two works in which were laid down their experiences during this memorable journey. Their record furnished to the compilers of the Chinese Annals a great deal of information on the ancient history

objets inflammables, afin d'augmenter l'intensité du feu, mais l'animal n'y fit aucune attention et ne se dérangea même pas. Enfin il sauta hors du brasier et se mit à marcher, ne paraissant avoir éprouvé aucun mal.' Quelques habitants de l'Ifrikiya assurent que, dans la ville de Cabes, ils avaient entendu raconter l'histoire de cet oiseau. Dieu seul sait si elle est vraie." In examining each for itself, we should certainly take both the Chinese and the Arabic story for an abstruse fable. Such a fire-proof bird most assuredly does not exist. On either side we are treated to the report of eye-witnesses. The two stories apparently are independent, although the subject is identical. After all, might this mysterious bird be an offshoot of the salamander-phoenix, restored to life by an overstrained imagination?

¹ *T'u shu tsi ch'êng*, XIX, chapter "Strange Animals," *hui k'ao* 3, p. 9.

of that country.¹ In the article on Fu-nan, inserted in the Annals of the Liang Dynasty (502—556),² we meet a curious notice on asbestos with reference to a Malayan region, as follows: "It is reported that Fu-nan is bounded on the east by the ocean known as Ta-chang 大漲 ('Great Expanse').³ In this ocean is a great island on which the kingdom of Chu-po 諸薄 (Java) is situated. East from this kingdom is the island of Ma-wu 馬五洲.⁴ Going again over a thousand *li* in an easterly direction across the Ta-chang Ocean, one reaches Volcano Island.⁵ On this island there

¹ PELLIOU, *Bull. de l'Ecole française*, Vol. III, p. 275.

² *Liang shu*, Ch. 54, p. 3; likewise in *Nan shi*, Ch. 78, p. 3.

³ Corresponding to our Chinese Sea, extending from Hai-nan to the Straits of Malacca.

⁴ PELLIOU (*Bull.*, Vol. IV, p. 270) is inclined to identify this island with Bali by assuming a clerical error ("Ma-li" for "Ma-wu").

⁵ *Tse jan huo chou* 自然火洲 (literally, "the island of fire which burns of itself"). PELLIOU (*Bull.*, Vol. III, p. 265) has justly recognized that the reading "great island" 大洲 in *Liang shu* and *Nan shi* is an error for "fire island." Indeed, the text of *Nan shi* is quoted with the correct reading in the *Wei lio* (Ch. 4, p. 3) of the Sung period, in an essay entitled "Asbestos." WYLIE, in his study *Asbestos in China* (p. 149), not consulted by Pelliot, translated the name by "spontaneous combustion great island." He accordingly accepted the wrong reading, and took the word *jan* in the sense of "to burn." The latter point of view is justified, as, for instance, the *Hüan lan* 玄覽 (*Ko chi king yüan*, Ch. 27, p. 13) writes 燃火之洲. Which of the numerous volcanic islands of the Archipelago, one of the chief volcanic belts on the globe, should be understood by K'ang T'ai's "Volcano Island," certainly is difficult to guess. In my opinion, Timor stands a fair chance of claiming this honor. A. R. WALLACE (*The Malay Archipelago*, p. 5) observes, "To the eastward, the long string of islands from Java, passing by the north of Timor and away to Banda, are probably all due to volcanic action. Timor itself consists of ancient stratified rocks, but is said to have one volcano near its centre." Again on p. 7, "In Timor the most common trees are Eucalypti of several species, so characteristic of Australia, with sandal-wood, acacia, and other sorts in less abundance. These are scattered over the country more or less thickly, but never so as to deserve the name of a forest. Coarse and scanty grasses grow beneath them on the more barren hills, and a luxuriant herbage in the moister localities. In the islands between Timor and Java there is often a more thickly wooded country, abounding in thorny and prickly trees. These seldom reach any great height, and during the force of the dry season they almost completely lose their leaves, allowing the ground beneath them to be parched up, and contrasting strongly with the damp gloomy, ever-verdant forests of the other islands. This peculiar character, which extends in a less degree to the southern peninsula of Celebes and the east end of Java, is most probably owing to the proximity of Australia. The

are trees which grow in the fire. The people in the vicinity of the island peel off the bark, and spin and weave it into cloth hardly a few feet in length. This they work into kerchiefs, which do not differ in appearance from textiles made of palm and hemp fibres,¹ and are of a slightly bluish-black color. When these are in the least soiled, they are thrown into fire and thoroughly purified. This substance is made also into lamp-wicks which never become

south-east monsoon, which lasts for about two-thirds of the year (from March to November), blowing over the northern parts of that country, produces a degree of heat and dryness which assimilates the vegetation and physical aspect of the adjacent islands to its own. A little further eastward in Timor-laut and the Ké Islands, a moister climate prevails, the south-east winds blowing from the Pacific through Torres Straits and over the damp forests of New Guinea, and as a consequence every rocky islet is clothed with verdure, to its very summit. Further west again, as the same dry winds blow over a wider and wider extent of ocean, they have time to absorb fresh moisture, and we accordingly find the island of Java possessing a less and less arid climate, till in the extreme west near Batavia rain occurs more or less all the year round, and the mountains are everywhere clothed with forests of unexampled luxuriance." "The land mammals of Timor are only six in number, one of which is a shrew mouse (*Sorex tenuis*), supposed to be peculiar to the island" (*ibid.*, p. 160).

¹ *Tsiao ma* 蕉麻. Pelliot renders this by "scorched hemp" (*du chanvre roussi*), as if the reading were 焦. Wylie translates the term "raw hemp;" but the word *tsiao* denotes a particular group of plants, the fibre-furnishing palms, and is co-ordinated with the word *ma* ("hemp"). Clothing of palm-fibres was particularly made by the aboriginal tribes of southern China, and known as *hung tsiao pu* 紅蕉布 (*hung tsiao* being a variety of the genus *Musa*; see the *Ch'i ya* 赤雅 by Kuang Lu, Ch. A, p. 5, ed. of *Chi pu tsu chai ts'ung shu*). The so-called Manila hemp of commerce is obtained from the Abaca (*Musa textilis*), the staple material for Filipino weavings (see C. R. DODGE, *Descriptive Catalogue of Useful Fibre Plants of the World*, pp. 248—249, Washington, 1897; and the recent interesting article of C. ELATA, *Philippine Fiber Plants*, in the *Philippine Craftsman*, Manila, 1914, pp. 442—456). MARCO POLO (ed. of YULE and CORDIER, Vol. II, p. 124) mentions that the people of the province of Kuei-chou manufacture stuffs of the bark of certain trees which form very fine summer clothing. I do not believe with Yule (p. 127) that Polo here refers to the so-called grass-cloth, but he indeed means literally cloth woven from the bark-fibres of trees. The Miao in the prefecture of Li-p'ing, province of Kuei-chou, indeed make textiles from tree-bark, called bark-cloth (*p'i pu* 皮布; see *Ta Ts'ing i t'ung chi*, Ch. 400, p. 4). According to Megasthenes (STRABO, xv, 60) the Sarmanes (Sanskrit *śramaṇa*, "ascetic") of India used to wear garments made from the bark of trees. The various kinds of hemp grown in China are briefly enumerated in *Chinese Jute*, published by Order of the Inspector General of Customs (Shanghai, 1891).

exhausted." This text presents a somewhat amazing effort at associating heterogeneous ideas. The real affair described is the well-known bast-cloth, common to the Malayan and Polynesian tribes, and peculiar to many other culture-areas, which assuredly is not incombustible; and this product is passed off as asbestos. The reference to the purification in fire and to the making of wicks doubtless proves that asbestos is intended. On the other hand, the resemblance of asbestos-fibres to hemp or flax is well-known.¹

The term "bark-cloth" is equivocal: it denotes principally two types,—one known under the Polynesian name *tapa*, in which the bast is flayed and pounded or macerated in water till it becomes soft and pliable;² and another, in which the bast-fibre shreds into filaments that may be spun and woven. As K'ang T'ai refers to the latter process, he must have had textiles of bast-fibre in mind. Ko Hung, as already stated, based his account of asbestos on K'ang T'ai's report, and was familiar with both beaten and woven bark-cloth; for he has established two vegetable varieties of asbestos,—one woven from the flowers of trees, the other prepared from bark.

¹ Hence our name "earth-flax" (Dutch *steenwlas*, that is, "stone flax;" German *Flachsstein*).

² This method is practised not only by the Malayo-Polynesian stock, but also by the negroes of Africa and the aboriginal tribes of America. Only a few instances from literature may be given, whose number might certainly be augmented by many others. W. MARSDEN (*History of Sumatra*, p. 49, London, 1811) says on this subject, "The original clothing of the Sumatrans is the same with that found by navigators among the inhabitants of the South Sea Islands, and now generally called by the name of Otaheitean cloth. It is still used among the Rejangs for their working dress, and I have one in my possession, procured from these people, consisting of a jacket, short drawers, and a cap for the head. This is the inner bark of a certain species of tree, beaten out to the degree of fineness required; approaching the more to perfection, as it resembles the softer kind of leather, some being nearly equal to the most delicate kid skin; in which character it somewhat differs from the South Sea cloth, as that bears a resemblance rather to paper, or to the manufacture of the loom." In central Celebes the art of weaving is still unknown, and the tribes use only beaten bark cloth derived from a large variety of trees (P. and F. SARASIN, *Reisen auf Celebes*, Vol. I, p. 259, where the process is described). See also DODGE, *l. c.*, pp. 98—101.

Is K'ang T'ai himself responsible for this fanciful combination, or did he merely reproduce a tradition overheard by him in Fu-nan? We know that K'ang T'ai, during his residence in that country in the first part of the third century, encountered a Hindu named Ch'ên-sung 陳宋, who had been despatched there by the King of Central India in response to the mission intrusted to Su-wu 蘇物 by Fan Chan 范旃, King of Fu-nan. Thus K'ang T'ai availed himself of the opportunity of interviewing Ch'ên-sung on all matters concerning India, and on his return to China published a work on the hundred and odd kingdoms of which he had heard. This valuable source of information has unfortunately perished.¹ India and Fu-nan entertained close commercial relations: diamonds, sandal-wood, and saffron being expressly mentioned in the T'ang Annals as products that were exchanged by India with Ta Ts'in, Fu-nan, and Kiao-chi (Tonking).² True it is, asbestos is not specified in the list of these products; but K'ang T'ai's story allows us a peep behind the scenes, for it incontrovertibly shows that asbestos was known in Fu-nan during the time of his sojourn. Certainly it could not have come from any Malayan region, where asbestos, as far as I know, is not found or utilized by the native population: it evidently arrived in Fu-nan from India. In A.D. 380 India presented to the Court of China an offering of fire-proof cloth;³ and this same event is alluded to in the Annals of the Tsin Dynasty, in the life of Fu Kien 苻健 (337—384),⁴ in the statement that India offered fire-proof cloth.⁵ We remember that Pliny naturalizes asbestos in India, that Hierocles equips the Indian Brahmans with

¹ PELLLOT, *Bull.*, Vol. III, p. 276.

² *T'ang shu*, Ch. 221 A, p. 10.

³ *Shi leu kuo ch'un ts'iu*, Ch. 37, p. 11 (compare WYLIE, *l. c.*, p. 143).

⁴ GILES, *Biographical Dictionary*, p. 230.

⁵ *Tsin shu*, Ch. 112 (compare *Pien tse lei pien*, Ch. 21, p. 6).

asbestos garments, and that the Arabs derived the mineral from Badakshān (pp. 320, 327): hence we are entitled to presume that asbestos was sometimes shipped also from India to Fu-nan in the beginning of the third century. This postulate is necessary to account for the fact that K'ang T'ai struck correct notions in Fu-nan regarding asbestos,—notions which agree with those of the classical authors. Asbestos products, however, were rare in Fu-nan, as in Hellas and Rome (PLINY, *rarum inventu*) and everywhere else, and the supply presumably could not keep pace with the demand; therefore the "malign and astute" people of Fu-nan¹ conceived the ruse to trade off Malayan bast-cloth under the name of "asbestos." This at least seems to me the best possible theory explaining K'ang T'ai's account, as far as the theory of vegetal origin is concerned. A specific example of what the Fu-nan asbestos was is offered by the interesting story of Duke Kie, discussed above, from which it appears that bast-cloth was really shipped to China under the label "asbestos." The merchants who offered this ware hailed from the Southern Sea, and this product must have been identical with what was shown K'ang T'ai on his visit in Fu-nan. Duke Kie's clever experiment also demonstrates that K'ang T'ai had merely fallen victim to a mystification.

The influence of the asbestos text in the Liang Annals is apparent not only in the Taoist school of the fourth century, as shown above, but also in several later works. Thus the *Hüan lan* or *Yüan lan* 玄(元)覽, a work of the T'ang period (618—906),² says, "In P'i-k'ien 毘騫 there is the Island of Blazing Fire, producing a tree the substance of which can be woven, and which furnishes what is called fire-proof cloth." The geographical term "P'i-k'ien"

¹ Thus they are characterized in the Annals of the Southern Ts'i (PELLIOT, *Bull.*, Vol. III, p. 261).

² Cited in *Ko chi king yüan*, Ch. 27, p. 13.

occurs in the Fu-nan account of the Liang Annals as the name of a great island of the ocean, situated 8000 *li* from Fu-nan, and, according to PELLIOU,¹ seems to have been along the Irrawaddy and the Indian Ocean. The information of the *Hüan lan*, of course, is deficient, as in the Liang Annals Volcano Island has nothing to do with P'i-k'ien, but is located far eastward, in the Malay Archipelago.

In the above translation of the passage of the Liang Annals, the kingdom of Chu-po has been identified with Java, the name being a variant of Shê-p'ò, by which Java became known from the first half of the fifth century. This conclusion is confirmed by a text ascribed to the *I wu chi* 異物志 and contained in the *T'ai p'ing yü lan*,² in which the Island of Blazing Fire is located in the kingdom of Se-tiao 斯調, which is doubtless a misprint for Ye-tiao 葉調. Now, we owe to the ingenuity of PELLIOU the identification of this name with the old Sanskrit designation Yavadvīpa,³ and this solution of the problem seems to me a well-assured result. Since the *I wu chi*, in its account of Volcano Island, depends upon the text of the Liang Annals, it seems equally certain that the Chu-po country mentioned in the latter is the island of Java. The passage of the *I wu chi* is worded as follows: "In the kingdom of Ye-tiao (Java) there is the Island of Blazing Fire, covered with a fiery plain, which lights up spontaneously in the spring and summer, and dies away during the autumn and winter. Trees grow there which do not waste, the branches and bark renewing their fresh appearance; in the autumn and winter, however, when the fire dies out, they all wither and droop. It is customary to gather the bark

¹ *Bull.*, Vol. III, p. 264.

² Ch. 820, p. 9 (edition of Juan Yüan, 1812). The text is quoted also in the commentary to *San kuo chi*, *Wei chi*, Ch. 4, p. 1.

³ *Bull.*, Vol. IV, p. 268; and *T'oung Pao*, 1912, p. 457.

in the winter for the purpose of making cloth. It is of a slightly bluish-black color. When it is soiled, it is thrown into fire again, and comes out fresh and bright.”¹ The interesting point here is that the trees alleged to yield asbestos are set in causal relation with the fire of the volcano, which transmits to the bark its fire-proof quality.

Two other texts may likewise be traced to the Fu-nan account in the Liang Annals. The *Hüan chung ki* 玄中記, written by Kuo 郭² of the fifth century, observes that “there is a volcano in the south, producing a tree which is used for fuel without being consumed; the bark, when woven, makes fire-proof cloth, of which there are two kinds.”³ The *Shu i ki* 述異記 (“Record of Wonderful Matters”), by Jên Fang 任昉, who lived in the beginning of the sixth century, annotates that “the fire of this active volcano in the south is extinguished in the twelfth month whereupon all trees push forth branches; while, when the fire rises again, the leaves drop, the same as in winter in China, When the wood is used for fuel, it is not consumed by the fire; and the bark, when woven, makes fire-proof cloth.” This version must be connected with one handed down in the *Wên hien t’ung k’ao* of Ma Tuan-lin, who erroneously says that the Volcano country (*Huo shan*) became known only at the time of the Sui (589—618), and then quotes the following from the “Customs of Fu-nan” (*Fu-nan t’u su* 扶南土俗), by K’ang T’ai:⁴ “Volcano Island is situated somewhat over a thousand *li* east of Ma-wu Island. In the spring the rains set in; and when the rainy season is over, the fire of the volcano

¹ Compare WYLIE, *l. c.*, p. 146.

² His personal name is unknown.

³ In agreement with *Pao-p’u-tse* (p. 332).

⁴ Compare PELLLOT, *Bull.*, Vol. III, pp. 275 and 276, note 2. My rendering is based on the text in *Yüan kien lei han*, Ch. 233, p. 19.

breaks forth. The trees in the forests of the island, when wetted by the rain, have a black bark, but, when affected by the fire, the bark assumes a white color.¹ The inhabitants of the adjoining isles gather this tree-bark during the spring, and weave it into cloth; they make it also into lamp-wicks. When but a bit soiled, they fling the cloth into fire, and this means purify it. There is, further, a mountain, north of the country Ko-ying (written Kia-ying 加營)² and west of Chu-po (Java), 300 *li* in circumference. The active eruption of fire opens from the fourth month, and ceases in the first month. During the period of volcanic activity the trees drop their leaves, as in China during the cold season. In the third month the people betake themselves to this mountain to peel the tree-bark, which is then woven into fire-proof cloth.”

The *Lo-ying kia lan ki* 洛陽伽藍記³ states that the country Kū-se 車斯 produces fire-proof cloth which is made from the bark of trees, and that these trees are not consumed by fire.⁴ The number of texts insisting on the vegetal origin of asbestos could doubtless be much increased; but those here assembled are sufficient to show that this doctrine, first traceable to K'ang T'ai, had obtained a permanent hold on the Chinese mind, despite the contradictory explanation based on the salamander. While the Chinese salamander versions unquestionably go back to Western traditions, I am not convinced that this is the case also with the vegetal theory. As set forth above (p. 306), I do not share the opinion of those who impute to Pliny a belief in a plant origin of asbestos.

¹ This observation, of course, relates in reality to asbestos.

² See PELLICOT, *Bull.*, Vol. IV, p. 278, note.

³ Records of the Buddhist Establishments in the Capital Lo-ying, written by Yang Hsuan-chi 楊衒之 in 547 or shortly afterwards (BRETSCHNEIDER, *Bot. Sin.*, pt. 1, No. 483; and CHAVANNES, *Bull.*, Vol. III, p. 383).

⁴ *T'u shu tsi ch'êng*, chapter on fire (*tsa lu*), p. 11 b. Kū-se is perhaps identical with Kū-shi 車師, designating “Turfan-Dsimsa.”

The tree-asbestos of the Alexander Romance and a Syriac work (p. 308) represents rather isolated instances which show lack of cohesion, and cannot be unduly emphasized. Asbestos filaments bear such a striking resemblance to hemp or flax fibres, that it becomes intelligible that the theory of their identity could have spontaneously been advanced in various parts of the world. Our own nomenclature of asbestos varieties is witness thereof.¹ In the following section I shall try to explain how this theory originated in Fu-nan.²

The Arabs and mediæval Europe, as already observed, were too much absorbed by the identification of asbestos with the salamander and phoenix to pay much attention to the idea of vegetal provenience. This view, curiously enough, loomed up in Europe in MARTINI'S *Atlas Sinensis*. It is told there that there is a kingdom

¹ The mountain-tree asbestos of the Chinese meets its parallel in our "mountain wood" or ligniform asbestos (*xyloïd*),—a variety of asbestos which is hard and close grained, generally of a brownish color, and often bearing an exact resemblance to petrified wood. At first sight it might easily be mistaken for the latter, especially when sufficient iron is present to give it the ruddy tinge of decayed wood or bark. Under the microscope, however, the crystal fibre is easily detected, as is also the absence of the vegetable cells which are always to be found in petrified wood (R. H. JONES, *Asbestos*, p. 14). Also the Chinese seem to have taken petrified wood for asbestos (see WYLIE, *l. c.*, p. 152; and the writer's *Notes on Turquois*, p. 24).

² An analogous example in which the ancients were deluded in regard to a Chinese product, is presented by Chinese silk taken by several classical authors for thin fleeces obtained from trees (YATES, *Texturum Antiquorum*, p. 182). VIRGIL (*Georgica*, II, 121) has the verse, "And Seres comb their fleece from silken leaves" (*Velleraque ut foliis depectant tenuia Seres*). STRABO (XV, 20) supposed the raw silk material to be a sort of byssos fibres scraped from the bark of trees. According to DIONYSIUS PERIEGETES, the Seres comb the variously colored flowers of the desert land to make precious figured garments, resembling in color the flowers of the meadow (*ibid.*, p. 181). PLINY (VI, 20) speaks of the Seres famed for the wool found in their forests; they comb off a white down adhering to the leaves, and steep it in water. The use of water to detach silk from the trees is insisted on also by Solinus and Ammianus Marcellinus, both of whom propound the vegetal theory of the origin of silk. Pausanias of the second century denied that the threads from which the Seres make webs are the produce of bark, and described the silkworm with fair correctness.

in Tartary styled Taniu, which produces stones; and above these, an herb which fire can never consume. When it is surrounded by flames, it reddens as though it would be entirely burned up; but as soon as the fire is out, it re-assumes its former gray or ash color. It is never very large or high; but it grows like human hair, and has almost the shape of the latter. Its consistency is very feeble and delicate; and when placed in water, it is noted that it turns into mud and is entirely dissolved.¹

THE VOLCANIC THEORY.—After having discussed the opinions of the animal and vegetal origin of asbestos, another question remains to be answered,—How did the idea of a volcano acting upon the formation of asbestos spring into existence and develop? Besides the volcanic theory propounded by K'ang T'ai, there are a few others that call for attention. The *Shi i ki*² records an embassy from the country of the Yü-shan bringing a tribute of fire-proof cloth to the Emperor Wu of the Tsin dynasty in the year 280. On this occasion the envoys of Yü-shan stated that "in their country there is a mountain containing veined stones (*wen shi* 文石) sending forth fire, the appearance of smoke being visible at the horizon throughout the four seasons. This fire was known as the 'cleansing fire.' When unclean clothes were thrown on these blazing stones, however big the accumulation of filth, they were purified in this manner, and came out as new." These clothes, of course, must have been of asbestos-fibres. This story is strange,³ and is hardly reproduced correctly in the Chinese text, as it is now before us. No reason can be discovered why asbestos-cloth should be cleaned in a volcanic

¹ A. KIRCHER, *La Chine illustrée*, p. 278 (Amsterdam, 1670). Kircher refutes this error; Martini's story is doubtless derived from the Chinese.

² Ch. 9, p. 4 (ed. of *Han Wei ts'ung shu*); compare WYLIE, *l. c.*, p. 143.

³ In all probability it is a mere echo and bad digestion of K'ang T'ai's narrative.

fire, as any other ordinary fire would answer the same purpose. The true story must have been so worded that asbestos itself was produced by the volcano in question, and that the agency of the volcanic fire to which it was exposed was instrumental in rendering it impervious to fire.¹ We have here, then, a reference to an asbestos-producing volcano situated in the west of China. A burning mountain beyond the K'un-lun, upon which any object that is thrown is immediately burnt, is mentioned in the *Shan hai king*;² and we have seen that the *Sou shên ki* derives asbestos from this volcano in the K'un-lun.³ Chinese tradition, accordingly, is acquainted with two volcanoes producing asbestos,—one on an island in the eastern part of the Malay Archipelago, first reported by K'ang T'ai; and another placed in Central Asia. From none of these territories, however, has asbestos ever become known to us: hence we are compelled to conclude that the volcanic theories of the Chinese records have not been prompted by immediate observation, but are the result of a series of speculative thoughts. These thoughts themselves, on the other hand, have a certain foundation in correct observation: it is in the manner of their concatenation that the speculative element comes in.

It may first be noted that from our scientific viewpoint even the direct association of asbestos with volcanoes is quite correct. In the widest sense of the word, we include under "asbestos" both pyroxene and hornblende; the latter most frequently, the former

¹ In a manner similar to that in which Pliny invokes the scorching heat of the tropical sun in the deserts of India as the cause of the fire-proof quality of the mineral.

² WYLIE, *l. c.*, p. 146.

³ The Sung History, according to BRETSCHNEIDER (*Mediæval Researches*, Vol. II, p. 190), describes a volcano north of Urumtsi, which contains sal ammoniac: "Inside there is a perpetual fire, and the smoke sent out from it never ceases; clouds or fogs are never seen around this mountain; in the evening the flames issuing from it resemble torch-light; the bats, from this phenomenon, appear also in a red color." Compare W. OUSELEY, *Oriental Geography of Ebn Haukal*, p. 264.

more rarely, assuming an asbestiform character. Pyroxene, a very common mineral, is a constituent in almost all basic eruptive rocks, and is principally confined to crystalline and volcanic rocks. In different localities it is associated with granite, granular limestone, serpentine, greenstone, basalt, or lavas. Likewise hornblende is an essential constituent of igneous rocks.¹ Nevertheless we cannot grant the Chinese the merit of having made such an observation, which is due solely to our modern geological research. There is, moreover, no volcano in Asia which to our knowledge has ever yielded asbestos, nor do the Chinese pretend to have actually imported the material from a volcanic region. To them the volcano is a romantic place of refuge to explain the perplexing properties of asbestos. The introduction of the volcano must not be explained by reading into it the latest achievements of our geology, but from the thoughts evolved by the nature philosophy of the Chinese, nourished by the glowing accounts accruing from foreign countries. The question will be difficult to settle, whether K'ang T'ai owes his theory to himself and his Chinese environment, psychological and educational, or whether he borrowed it outright from the people of Fu-nan. I feel positive of the one fact, that the volcanic point in it was conceived in Fu-nan; for China has no volcanoes, and all Chinese accounts of such relate to countries abroad.²

¹ R. H. JONES, *Asbestos*, p. 21. Asbestos occurs in high altitudes. In Italy, for instance, it is rarely found at a lower level than five thousand feet, ranging from this upwards to twelve thousand; in fact, up to the line of perpetual snow. Hence the addition "mountain" is so prominent in our names for the varieties; as, "mountain wood," "mountain leather," "mountain paper," "mountain cork," "mountain flax."

² There is a negative criterion which illustrates that the Fu-nan tradition of the volcanic asbestos is not due to an impetus from outside. The Arabic authors make frequent allusions to the volcanoes of Java and neighboring islands, but never mention asbestos in this connection. Ibn Khordābeh, in his *Book of the Routes and Kingdoms* (844—848), tells of a small volcano in Jāba (Java), a hundred cubits square, and only of the height of a lance, on the summit of which flames are visible during the night, while it throws up smoke during the day. The merchant Soleiman, who wrote in 851, speaks of a

To K'ang T'ai, asbestos-fibres were of vegetal origin, the product of the bark of a tree, somewhat on the order of palm or hemp fibre. The ready-made textile was impervious to fire, and the mind eager to account for this wonder of nature settled on the theory that this property should have been brought about through the action of a natural fire. The material in its crude state had already habituated itself to fire, which had hardened it in such a manner that it could successfully resist all attacks of the element,—an idea also alive in Pliny's mind. People of Fu-nan who had occasion to visit certain Malayan islands with their belt of volcanic mountains observed the great luxury of vegetation which there prevailed, and its endurance despite volcanic eruptions. PLINY tells us of an ash-tree overshadowing the fiery spring of a volcano and always remaining green.¹ Chao Ju-kua, describing the action of Mount Etna, observes, "Once in five years fire and stones break out and flow down as far as the shore, and then go back again. The trees in the woods through which this stream flows are not burned, but the stones it meets in its course are turned to ashes."² If there were plants to outlive the ravages of volcanic destruction, the primitive mind argued that the absorption of subterranean fire had made them fire-proof. The fibres of asbestos, being fire-proof, were consequently derived from plants growing on volcanic isles, this association being facili-

Mountain of Fire near Jāwaga (Java) which it is impossible to approach; at its foot there is a spring of cold and sweet water; the same is reiterated by Ibn al-Faḡh (902). Masūdī (943) reports a tradition regarding the Malayan volcanoes, according to which, during the thunder-like eruptions, a strange and terrifying voice resounded announcing the death of the king or chief, the sounds being louder or lower in accordance with the importance of the person (see G. FERRAND, *Relations de voyages arabes, persans et turks rel. à l'Extrême-Orient*, Vol. I, pp. 28, 41, 59, 99, 110, 145; and CARRA DE VAUX, *Maḡoudi, Livre de l'avertissement*, pp. 90—92). Not one of these or any later Arabic writers mentions asbestos among the products of either Java or any other Malayan region.

¹ Viret aeterno hunc fontem igneum contegens fraxinus (II, 107, § 240).

² Translation of HIRTH and ROCKHILL, p. 154.

tated by the fact that their inhabitants manufactured fabrics of bark-fibres. That this hypothesis was formulated in Fu-nan appears plausible to a high degree; for, aside from the inward probability of this supposition, there is no such account in classical antiquity, Western Asia, or India. Pliny neither correlates asbestos with volcanoes, nor does he speak of asbestos in his discourse on the latter.

The report of K'ang T'ai, duly adopted by his countrymen, was then crossed by the salamander story inflowing from the Roman Orient, and the imaginative Taoists at once set to work to reach a compromise between the salamander-asbestos and the volcanic tree-bark asbestos. If the vegetable kingdom in certain places could survive a volcanic fire, and if, as stated by Western traditions, the salamander could exist in fire, there was in all the world no reason why the hardy creature could not stand a *volcanic* fire as well. This was the act of Kuo P'ò, who ejected the trees and replaced them by the salamander, that now made its home in the blazes of Volcano Island in the Malay Archipelago (p. 335). To the author of the *Sou shên ki*¹ this compromise seemed too radical, and he arbitrated by restoring K'ang T'ai and bringing Kuo P'ò to honor. The vegetable as well as the animal kingdom, in his way of reasoning, can live in volcanic fires; and asbestos is either the product of the bark of these plants, or of the plumage of birds or the hair of beasts. Wang Mou of the Sung period accepted this verdict, and acquiesced in the belief that there is foundation for both these statements.²

DISCOVERY OF ASBESTOS ON CHINESE SOIL.—The Annals of the Later Han Dynasty, in the interesting chapter dealing with the

¹ Ch. 13, p. 3 (of the Wu-ch'ang print).

² WYLIE, *l. c.*, p. 147.

southern Man (*Nan Man*) and the barbarous tribes in the south-west of China (*Si-nan I* 西南夷), have the following report: "Their contributions of tribute-cloth, fire-down (*huo ts'ui* 火毳), parrots, and elephants, were all conveyed to the Treasury."¹ WYLIE² refers this account to the tribe called Jan-mang 冉駹,³ mentioned in this chapter of the *Annals* a couple of pages before; but it would seem that it relates in fact to the Pai-ma-ti 白馬氏,⁴ a tribe settled in Sze-ch'uan Province (north-east of Mao chou).⁵

The term "fire-down," employed in the text of the *Annals*, is explained by the commentary as being identical with the term "fire-proof cloth" (*huo huan pu*); that is to say, it is understood by the Chinese in the sense of asbestos. The word *ts'ui* is very ancient, and appears as early as the time of the *Shi king*⁶ with the significance of clothing woven from the down of birds or the fine undergrowth of hair of mammals.⁷ Such textiles woven from bird's down are ascribed by the Chinese also to the aboriginal tribes inhabiting southern China. E. H. PARKER⁸ has extracted from the *Ling nan i wu chi* the information that the chiefs of southern China select the finest down of the geese and mix it with the

¹ *Hou Han shu*, Ch. 116, p. 11 b.

² *L. c.*, p. 150.

³ He wrongly transcribes the first character *Tan* (compare HIRTH, *China and the Roman Orient*, p. 36). The tribal name *Mang* is doubtless identical with the Mang 莽 studied by G. DEVÉRIA (*Frontière sino-annamite*, p. 159); see also CHAVANNES, *T'oung Pao*, 1906, p. 689.

⁴ *Ibid.*, p. 11 a.

⁵ Compare the interesting study of J. H. PLATH, *Fremde barbarische Stämme im alten China*, p. 515 (*SB. bayer. Akad.*, 1874). The Pai-ma-ti seem to have extended from Sze-ch'uan as far as into Kan-su (CHAVANNES, *T'oung Pao*, 1905, p. 528).

⁶ LEGGE, *Chinese Classics*, Vol. IV, p. 121.

⁷ It is only the soft down of wild birds and wild beasts. The translation "habille-ment fait en laine," given by BIOT (*Le Tcheou-li*, Vol. II, p. 6), is erroneous, as already pointed out by J. H. PLATH (*Nahrung, Kleidung und Wohnung der alten Chinesen*, p. 37); also COUVREUR has the wrong rendering, "vêtement de laine."

⁸ *China Review*, Vol. XIX, p. 191.

threads of white cloth to make coverlets, the warmth and softness of which are not inferior to those of soft floss cushions. In other words, Mr. Parker adds, eider-down quilts were known in China very long ago. D. I. MACGOWAN, in his highly interesting essay *Chinese and Aztec Plumagery*,¹ makes this contribution to the subject: "A work styled 'New Conversations on things seen and heard at Canton,' was written by a native of Su-chou who spent many years in that city in a mercantile capacity in the latter part of the last century. In a short section devoted to bird clothes, he says, 'There are several kinds of birds, the feathers of which are woven into a peculiar cloth by the Southern Barbarians. Among them is the celestial goose velvet,² the foundation of the fabric being of silk, into which the feathers were ingeniously and skilfully interwoven, on a common loom, those of a crimson hue being the most expensive. Of these wild goose feathers, two kinds of cloth were made, one for winter, the other for summer wear. Rain could not moisten them; they were called 'rain satin,' and 'rain gauze,' respectively. Canton men imitated the manufacture, employing feathers of the common goose, blending them with cloth. This fabric, though inferior in quality, was much cheaper.'" The tribe Nung 儂 in Kuang-si made a special industry of fabricating a tissue of cotton and goose-down.³ Kuang Lu 鄺露, who spent several years among the Miao tribes in the service of one of the female chiefs,⁴

¹ *American Journal of Science and Arch.*, 2d ser., Vol. XVIII, 1854, p. 59. This important study has been unduly forgotten by the present, and I apprehend also by the preceding generation. Neither Bretschneider nor Hirth, in their references to *so-fu*, has ever appealed to it, and acquaintance with this treatise would doubtless have led them to better results.

² Apparently a literal translation of *t'ien ngo jung* 天鵝絨 ("silk-floss of the wild swan"). I find this term mentioned in the *T'ien kung k'ai wu* (Ch. 2, p. 46) as the name of a fur garment woven from down and feathers of hawks and wild geese.

³ G. DEVÉRIA, *Frontière sino-annamite*, p. 112.

⁴ WYLIE, *Notes on Chinese Literature*, p. 59.

and wrote an interesting account of them in his book *Ch'i yü* 赤雅,¹ mentions the bird-feather textiles under the name *niao chang* 鳥章 and discriminates between fine feather weavings styled *so-fu* 鎖袱² and coarse feather textiles termed "goose fishing-nets" (*ngo ki* 鵝罽).

This evidence permits us to infer that the term *huo ts'ui*, as applied to asbestos coming from the South-western Barbarians,³ signifies "bird-down able to resist fire," and accordingly echoes a tradition current among these barbarians themselves. If nothing else, the peculiar choice of this term, which occurs in no other text, would amply support this opinion. The conclusion that the barbarians themselves worked this fibrous asbestos into a textile would of course not be forcible; at least, it is not imperative, and it is sufficient to assume that they had gotten hold of the raw material. When we further consider that parrots⁴ and elephants named in the Annals are local products, the conclusion may be hazarded that also asbestos was found in the same region. This impression is confirmed by a statement of Yang Shên 楊慎 (1488—1559) to the effect that "fire-proof cloth is produced in Kien-ch'ang 建昌 in Shu (Sze-ch'uan). This substance is as white as snow, and is obtained from crevices in the stones, being identical with what the Annals of the Yüan Dynasty term 'stone silk-floss' (*shi jung* 石絨)." ⁵ An asbestos-producing locality in

¹ The preface is dated 1635. The passage is in Ch. A, p. 5 b of the reprint, in *Chi pu tsu chai ts'ung shu*.

² The Arabic word *ṣūf* صوف (T. WATERS, *Essays on the Chinese Language*, p. 355).

³ The occurrence of the term in the Han Annals is an isolated instance.

⁴ In the text "trained birds," interpreted as parrots. Parrots are first mentioned in *Ts'ien Han shu* (Ch. 6, p. 6) under the name "birds able to speak" (*néng yen niao* 能言鳥). They are frequently referred to in the Annals as tribute gifts (for instance, *Kiu T'ang shu*, Ch. 198, p. 9 b; *T'oung Pao*, 1904, p. 40).

⁵ *Ko chi king yüan*, Ch. 27, p. 13 (compare WYLLIE, *l. c.*, p. 153). Regarding the asbestos of the Yüan see below.

Sze-ch'uan is here clearly pointed out; and this agrees with the statement of F. P. SMITH¹ that asbestos is met with in Mao chou, Sze-ch'uan; and, as the Pai-ma-ti were settled near this region, they were very well within reach of asbestos.

It is not surprising that these "barbarians" had come into possession of asbestos; for this mineral is found on the surface in numerous places of this globe, and there are instances on record that it has accidentally been discovered even by primitive tribes. In 1770 P. S. PALLAS² reported that the Bashkir, a Turkish tribe in the region of Yekaterinburg, had discovered on a mountain a coarse kind of asbestos of yellowish-gray hue, being exposed to the air in large pieces split lengthwise, with brittle fibres which could be pulverized into a hard white wool. In the same area he visited also the Asbestos or Silken Mountain,³ giving a circumstantial account of the occurrence and mining there of the mineral, and mentioning also that an old woman had possessed the knowledge of weaving it into incombustible linen and gloves and making it into paper.⁴

The most remarkable utilization of asbestos on the part of a primitive tribe is made by the Eskimo. D. CRANTZ⁵ has the

¹ *Contributions toward the Mat. Med. of China*, p. 26.

² *Reise durch verschiedene Provinzen des russischen Reichs*, Vol. II, p. 134.

³ In Russian *Sholkovaya Gora* (*ibid.*, p. 184).

⁴ R. H. JONES (*Asbestos*, p. 37), not familiar with the interesting account of Pallas, represents the matter as though this site had been discovered only shortly before 1890, and even asserts that the Silken Mountain is said to be entirely composed of asbestos. It seems well out of the question that the Technical Society of Moscow, on whose report Jones falls back, could have made such an absurd statement, for Pallas had already said that the mountain consists principally of slate. His investigation is apt to refute also Jones's preposterous allegation that up to the present time little use has been made of asbestos in Russia and Siberia, "on account of the prevailing ignorance respecting its peculiar properties." As early as 1729 news was spread in Russia of an incombustible linen from Siberia. This referred to an asbestos-quarry discovered there about 1720 (P. J. VON STRAHLENBERG, *Nord- und östliche Teil von Europa und Asia*, p. 311, Stockholm, 1730).

⁵ *The History of Greenland*, Vol. I, p. 56, London, 1767.

following observation on the occurrence and utilization of asbestos in Greenland: "The amiantus and asbestos or stone-flax are found in plenty in many hills of this country. Even in the Weichstein are found some coarse, soft, ash-gray veins, with greenish, crystalline, transparent *radii* shooting across them. The proper asbestos or stone-flax looks like rotten wood, either of a white-gray, a green, or a red cast. It has in its grain long filaments or threads, and about every finger's length a sort of joint, and the broken end is hard and fine like a hone. But if it is pounded or rubbed, it develops itself to fine white flaxen threads. When this stone is beaten, mollified and washed several times in warm water from its limy part that cemented the threads into a stone, then dried upon a sieve, and afterwards combed with thick combs which the clothiers use, like wool or flax, you may spin yarn out of it and weave it like linen. It has this quality, that it will not burn, but the fire cleanses it instead of lye or suds. The ancients shrouded their dead, and burnt or buried them, in such incombustible linen. They still make purses or such kind of things of it for a curiosity in Tartary and the Pyrenean mountains. Paper might be made of this linen. The purified filaments may also be used as we use cotton in a lamp. But we must not imagine that the Greenlanders have so much invention: They use it dipped in train (for as long as the stone is oily, it burns without consuming) only instead of a match or chip, to light their lamps and keep them in order." In the *Encyclopædia Britannica* ¹ it is stated that "by the Eskimo of Labrador asbestos has been used as a lamp-wick." I do not know from what source or authority this statement comes; but, in view of the data of Crantz, it does not sound very probable.

Marco Polo's account has shown us that in the time of the

¹ Vol. II, p. 714.

Mongols asbestos was dug, that its preparation and weaving were perfectly understood, and that asbestos products were utilized in China. From this time onward we no longer hear of imported "fire-proof cloth," while the accounts of native asbestos increase. As early as the Sung period an attempt had been made in the Imperial Atelier to spin and weave asbestine fibres imported by the Arabs into cloth, but not with brilliant success.¹

A positive allusion to a locality where asbestos was found during the Mongol period is made in the biography of the treacherous Uigur minister Ahmed (A-ho-ma),² who, in a memorial to the Emperor Kubilai, stated that "Mount Pu-ko-ts'i 布格齊 produces asbestos, which is woven into cloth unconsumable by fire; an officer should be despatched to gather it." In the main section of the Annals³ the date of this memorial is fixed in the year 1267, and it is added that the Emperor indorsed it and issued an order in compliance with the request. The term for "asbestos" used in this text is *shi jung* 石絨 (literally, "stone silk floss"). We have already seen that Yang Shên (1488—1559) pronounced this term identical with what is generally known as "fire-proof cloth," that is, asbestos; and this identification is certain beyond doubt.⁴

¹ *T'ie wei shan ts'ung t'an* (already quoted above, Ch. 5, p. 20 b).

² *Yüan shi*, Ch. 205, p. 2 a. He figures among the "Villainous Ministers." Marco Polo has told his story (ed. of YULE and CORDIER, Vol. I, p. 415).

³ *Yüan shi*, Ch. 6, p. 12.

⁴ Giles, Schlegel, and the English and Chinese Standard Dictionary, have adopted it in this sense. The term with the same meaning is used in Japan (GEERTS, *Produits*, p. 450). Also Chang Ning 張寧 of the Ming, author of the *Fang chou tsa yen* 方洲雜言, combines the "stone silk floss" of the Mongols with the ancient tributes of fire-proof cloth (*Pien tse lei pien*, Ch. 21, p. 6; WYLIE, *l. c.*, p. 153). An analogous expression occurs in the form *shi ma* 石麻 ("stone hemp") in the *Tung ming ki* (*P'ei wen yün fu*, Ch. 21, p. 4 b). This text would possess a veritable value if any dependence could be placed on this spurious work (see CHAVANNES and PELLIOU, *Traité manichéen*, p. 145), which may reach back to the middle of the sixth century. The passage in question, however, cannot be exactly dated, nor can the mysterious country Pu-tung be identified

In regard to the location of Monnt Pu-ko-ts'i, Wylie, who has already called attention to this passage,¹ observed that it is difficult to identify it; but, "as asbestos is said to be found in Tartary, it is not unreasonable to suppose a coincidence in this also." G. SCHLEGEL² writes the name of the mountain 別怯赤山,³ translating this by "red mountains of Pie-kieh," which he places in Sze-ch'uan at 27° 12' latitude and 102° 53' longitude.⁴

A. WILLIAMSON⁵ seems to be the first European author to record the occurrence of the mineral in Shan-tung. Under the title "asbestos" he has the following: "This strange fossil mineral is found at King-kwo-shan, and also at Law-sze-shan. The natives use it for making fire-stoves, crucibles, and other fire-proof purposes. The fibre is good and very feathery, and by the admixture of cotton or hemp could be woven into articles of clothing. Such articles being exposed to fire and having all the alloy consumed, would

(it appears only in this passage, as shown by *Pien i tien*, Ch. 42, where Pu-tung is ranked among the unidentified countries of the East, solely with reference to this text). The allusion to asbestos is obvious. The text runs thus: "In the lake Ying-ngo 影娥池 there are ships fastened by means of 'stone veins' (*shi mo* 石脈) worked into ropes. These 'stone veins' come from the country Pu-tung 晡東, and are as fine as silk floss. They are extracted from the stone, and reeled like hempen cordage. The material is styled 'mineral hemp,' and is also made into cloth." The passage, at any rate, demonstrates that the mineral character of asbestos was known to the Chinese prior to the age of the Yüan, and possibly during the sixth century. The following text from the Persian geography of Ahmed Rāzī of the sixteenth century and relating to Egypt might eventually be enlisted for the explanation of the Chinese story. It is thus translated by C. HUART (*Publ. de l'Ecole des Langues Orientales*, 5th ser., Vol. V, 1905, p. 121): "Dans certaines localités croît une herbe dont on fait les cordages des gros navires; elle donne une lumière à la façon d'une chandelle; quand elle s'éteint, on la fait tourner plusieurs fois et elle redevient lumineuse."

¹ *L. c.*, p. 152.

² *Nederlandsch-chineesch Woordenboek*, Vol. III, p. 1066.

³ This is the reading of the *Fang chou tsa yen*.

⁴ It would be interesting to settle this question. Thus far, I have failed to find any indications in the *Yüan shi* regarding the site of this mountain.

⁵ *Notes on the Productions of Shan-tung* (*Journal China Branch R. As. Soc.*, Vol. IV, 1868, p. 70).

afterwards form fire-proof garments, such as ancient history speaks of, and such as are used in legerdemain. But the mineral would make most excellent fire-brick, which would be cheaper and more durable than any others. This is worthy of the consideration of the masters of the steamers on the coast." Unfortunately Williamson did not supply the technical name by which the substance is known to the Chinese. This defect was made good by F. P. SMITH,¹ who furnished the name *pu hwei mu* 不灰木 (literally, "wood without ashes;" incombustible wood), and pointed out three localities where it is obtained,—Lu-ngan fu in Shan-si, district of Yü-t'ien in Tsun-hua chou in Chi-li, and Mao chou in Sze-ch'uan. The occurrence in Shan-tung was confirmed by A. FAUVEL,² who stated that "asbestos is common in Shan-tung; pounded and mixed with soapstone it is made into crucibles, and very pretty white Chinese furnaces; they are as light as cardboard, and stand any heat; these articles are extensively made in the capital of the provinces." In this account I have full confidence, because Fauvel was a good naturalist and observer, and because I saw and collected such stoves myself. These specimens, six in number,³ were obtained at Peking in 1903; and from the description given me by Chinese, there could be no doubt that they were really made of asbestos. This impression is corroborated by Professor L. P. Gratacap, Curator of the Department of Mineralogy in the American Museum of Natural History of New York, who states that these stoves "consist of a very finely triturated asbestos, with which (purposely or adventitiously I cannot say) there is an admixture of particles of

¹ *Contributions toward the Mat. Med. of China*, p. 26.

² *China Review*, Vol. III, 1875, p. 376.

³ In the American Museum, New York (Cat. Nos. 12427, 12652—12656). A specimen is figured in the *Catalogue of the Chinese Collection for the International Health Exhibition, London, 1884*, p. 82, and is defined there as "lime stove."

limestone; there is evidently also a smearing of clay, which to a slight extent pervades also the asbestiferous mass." As this substance is designated by the Chinese in Peking *pu huei mu*, it is conclusively proved that at present this term relates to a variety of asbestos, though this does not imply that it might not refer also to other lime-like minerals which in our opinion do not come under that category. These asbestos stoves, white in color, enclosed in frames of wood or brass and heated with coal-briquettes, are much utilized in Peking and manufactured about 80 *li* in the hills toward the west of the metropolis. I could not learn the name of the village or locality.¹

GEERTS² pointed out that *pu huei mu* denotes in Japan incrustations of carbonate of lime, which settle around branches of trees immersed in a current of mineral water. This may be; in China this term refers also to petrified wood.

In reading the notes of Li Shi-chên³ on the subject of *pu huei mu*, we are struck by the fact that he does not make any allusion

¹ The *Port Catalogues of the Chinese Customs' Collection at the Austro-Hungarian Universal Exhibition, Vienna, 1873* (p. 56) contain the following entry in the Chefu collection (repeated also in later Exhibition Catalogues of the Customs): "Asbestos, *lung-ku-ni* 龍骨泥; place of production, Shan-tung; used for making fire-stoves, crucibles, etc.; the fibre woven with cotton or hemp is made into fire-proof materials." This information is spurious, and based on a misunderstanding of Williamson, who said that the fibre is good and very feathery, and by the admixture of cotton or hemp *could* be woven into articles of clothing; in fact, of course, it is not so woven by the Chinese, nor is it woven by them at all; at least, there is not the slightest evidence of this. Moreover, the term *lung-ku-ni* has nothing to do with asbestos, but denotes a medical preparation made from powdered dragon-bones, that is, bones of fossil animals.—How badly China is treated by our mineralogists, and even in otherwise complete monographs, is illustrated by the book of R. H. JONES on Asbestos. All that is said there in regard to China amounts to the one sentence (p. 39), "In China also asbestos occurs; but, apart from the manufacture of a coarse kind of cloth, we know little of any purpose to which it is there applied." I have never seen or heard of any asbestos-cloth now manufactured in China.

² *Produits*, p. 450 (see also p. 344).

³ *Pén ts'ao kang mu*, Ch. 9, p. 14 b. The translation given by F. DE MÉLY (*Lapidaires chinois*, p. 85) is an incomplete abstract from the *Pén ts'ao*.

to the "fire-proof cloth;" he does not tell us that it is identical with what anciently was called *huo huan pu*. In fact, the traditions regarding the two products are entirely distinct. Certainly *pu hwei mu* refers to the mineral, and *huo huan pu* to the finished textile product.

There is another term, *yang k'i shi* 陽起石, which likewise refers to a variety of asbestos. It is difficult to see why SMITH¹ and GEERTS² were so much exercised about this identification, the one saying that "this variety of hornblende, or greenstone, is scarcely to be called an asbestos, as it is by some writers;" the other even going so far as to impeach some foreign authors on a charge of confusion. Both Smith and Geerts were insufficiently informed on the subject; for what they describe is certainly styled by us "asbestos," whether the Chinese specimens commercially be of good or bad quality. D. HANBURY³ identified *yang k'i shi* with "asbestos tremolite,⁴ silicate of lime and magnesia;" and this is what we still include under "asbestos." It appears that this stone is used only medicinally.⁵ The *English and Chinese Standard Dictionary*⁶ lists both *pu hwei mu* and *yang k'i shi* under "asbestos."⁷

¹ *L. c.*, p. 27.

² *L. c.*, p. 448.

³ *Notes on Chin. Mat. Med.*, p. 111 (*Pharmaceutical Journal*, 1861); or in his *Science Papers*, p. 218.

⁴ This word is derived from Tremola, Mount St. Gotthard, where this variety was first found.

⁵ F. DE MÉLY, *Lapidaires chinois*, p. 105; BLOT in Bazin, *Chine moderne*, p. 556.

⁶ Vol. I, p. 112.

⁷ It should be pointed out, however, that this meaning of *yang k'i shi* is of comparatively recent origin, the exact date of which remains to be ascertained. In the older texts cited by Li Shi-chên on the subject, nothing can be found to remind us of asbestos; and the early sources are so brief and obscure that they hardly allow of any positive conclusions. Thus the *Pie lu* merely refers to Shan-tung as the place of provenience by saying that *yang k'i shi* occurs in the hills and valleys of Mount Ts'i and in Lang-ye, adding that it is the root of mica (*yün mu*, "cloud mother") in the Cloud Mountains (*Yün shan*). T'ao Hung-king states that this mineral, which is dug together with mica,

Marco Polo proved that he was possessed of a scientific mind when he exploded the salamander legend at the very moment that his Turkish acquaintance told him of how asbestos was dug and spun. The same case might be applied as a test for the scientific ability of the Chinese. True it is, the scholars of the Ming period clearly recognized the identity of the asbestos discovered under the Yüan with the imported fire-proof cloth of old. In vain, however, do we look in the literature of the Chinese for an awakening on their part, and a critical attitude toward the ancient legends, when the mining and working of the material within their boundaries has offered the opportunity ever since the days of the Mongols. The minds of Chinese scholars, at least those of the last centuries, were not trained to observation, and still less to logical conclusions based thereon, especially when these were apt radically to antagonize venerable traditions. The discovery of asbestos in China did not lead to studies by her scholars and to an overthrow of popular errors. On the contrary, the old book-knowledge persisted and triumphed. Wylie quotes the following from Chou Liang-kung 周亮工, an author who lived under the Manchu dynasty and had occasion to see a strip of asbestos cloth: "The ancients said that it was woven from the bark of a tree that grew on a burning mountain; while some say that it is from the hair of a rodent. The statement that it is from the bark of a tree, is the most

is very similar to mica, only of greater density; and that *yang k'i shi*, dug in Yi-chou together with alum (*fan shi*), is a bit yellow and black in color, but that it is only the root of alum or mica, and that the true state of affairs is not yet assured. T'ao Hung-king, accordingly, was not positive about the true nature of the substance; it may originally have been a variety of mica or alum. At any rate, it has no practical importance for the historian of asbestos, as the Chinese never made any use of it in the manner of asbestos, but only took it internally as a medicine. It should be remembered that Apollonius has allusions to mica in his account of asbestos (p. 304), and that Dioscorides and Pliny liken asbestos to alum (pp. 303, 308).

probable, as its color is more like hempen than woollen fabrics." To the credit of the Chinese, however, it must be said that Ts'ai T'iao 蔡條 of the Sung period plainly rejected the legend of the animal origin of asbestos, though he failed to grasp the real nature of the substance. It will be remembered that this author, in his work *T'ie wei shan ts'ung t'an*, reports the importation on the part of the Arabs of asbestine cloth and asbestos raw material, and that the latter was woven into textiles in the Imperial Atelier of the house of Sung. These facts impressed the Sung scholars and set them to thinking. Ts'ai T'iao makes the positive statement that asbestos is not the hair of a rodent (非鼠毛也), and that the Chinese manufactures of his time testify to the fact that the old stories are wrong.

ADDENDA.—In the letter purported to have been addressed by Prester John to the Byzantine Emperor Manuel, and written about 1165, we read the following about the salamander yielding the material for asbestine garments (F. ZARNCKE, *Der Priester Johannes* I, p. 89): "In alia quadam provincia [of India, the territory of the alleged Royal Presbyter] iuxta torridam zonam sunt vermes, qui lingua nostra dicuntur salamandrae. Isti vermes non possunt vivere nisi in igne, et faciunt pelliculam quandam circa se, sicut alii vermes, qui faciunt sericum. Haec pellicula a dominabus palatii nostri studiose operatur, et inde habemus vestes et pannos ad omnem usum excellentiae nostrae. Isti panni non nisi in igne fortiter accenso lavantur." In this description the salamander is associated with the silkworm working itself an envelope that is reeled off and spun like silk, the material being incombustible and washed in fire. In view of the popularity of the stories about Prester John in the thirteenth century, the "salamander-silk," so frequently mentioned in the texts of that period, may well be traceable to the passage in question. In one of the mediæval manuscripts edited by Zarncke (pp. 167, 170), twelve men appear before King Manuel as ambassadors of the Presbyter, and impress him by cleaning their robes of salamander-silk in flaming fire. The Presbyter's letter is instructive for another reason; for it shows, as pointed out on p. 325, that the identity of the salamander's product with asbestos was not recognized in the early middle ages. The bread, it is told there, is baked in a vessel made from asbestos; the pavement is of green topaz, which by nature is cold, to moderate the heat of asbestos (A pistoriibus panis efficitur et in clibano facto

ex asbesto ponitur et coquitur. Pavimentum clibani est de topazio viridi, qui naturaliter est frigidus, ut caliditas asbesti temperetur. Alioquin panis non coqueretur sed combureretur. Tantus est calor asbesti). The walls of a furnace in the bakery (pistrinum) were likewise of asbestos (Est enim furnus factus exterius de lapidibus preciosis et auro, interius caelum et parietes sunt de albesto lapide, cuius natura talis est, quod, semel calefactus sit, deinde inremissibiliter sine igne semper erit calidus). These passages concerning asbestos are wanting in the original text of the letter, and are interpolations occurring in manuscripts of the thirteenth century.

Falstaff, after many uncomplimentary remarks on Bardolph's personal appearance, exclaims, "I have maintained that salamander of yours with fire any time this two and thirty years; God reward me for it!" (SHAKESPEARE, 1 *Henry IV*, III 3, 52). A lizard in the midst of flames was adopted by Francis I as his badge, with the legend, *Nutrisco et extinguo*, "I nourish and extinguish" (E. PHIPSON, *Animal Lore of Shakespeare's Time*, p. 320).

P. 339, note 1. The French translation of the text in question by d'Hervey-St.-Denys has been rendered into English by S. W. WILLIAMS in his article *Notices of Fu-sang* (*J. A. O. S.*, Vol. XI, 1882, p. 98). It appears from this translation as though in the opinion of Duke Kie Volcano Island were situated in the land of the Amazons, about ten thousand *li* north-west of Fu-sang; nor is the cloth from the bark of the fiery tree mentioned in it. In the translation of Williams it runs thus: "In the middle of the kingdom is an island of fire with a burning mountain, whose inhabitants eat hairy snakes to preserve themselves from the heat; rats live on the mountain, from whose fur an incombustible tissue is woven, which is cleaned by putting it into the fire instead of washing it." In fact, the text, as reprinted in *T'u shu tsi ch'êng*, is worded as follows: "Southward [from the country of Women or Amazons], arriving at the southern shore of Volcano Island, the inhabitants on Mount Yen-kun there subsist on . . . crabs and bearded snakes in order to ward off the poisonous vapors of the volcanic heat. In this island there are fiery trees, the bark of which can be wrought into cloth. In the blazing mound live fiery rodents, whose hair can be made into stuffs. These are incombustible, and when soiled, are cleaned by means of fire" (南至火洲之南炎崑

山之上其土人食蜃蟹髯蛇以辟熱毒洲中有火木其皮可以爲布炎丘有火鼠其毛可以爲褐皆焚之不灼汚以火浣).

Yen-kun is an artificially coined term, which does not appear in other texts; it is apparently intended for "blazing (*yen*) Kun-lun." The exact meaning of *sū* 蜃 is not known to me; according to K'ang-hi it is identical with 蜃 蚌. The interesting feature of the above text is that the asbestos and salamander story is linked together with fabulous accounts of Fu-sang and the Amazons, and it will be remembered

that the report of a specular lens coming from Fu-sang is embodied in the same text (this volume, p. 198). If I expressed the view that this lens appears to have been of Western origin, and that Chang Yüe was familiar with traditions relating to Fu-nan, India, and Fu-lin (p. 204), this opinion is confirmed by the present case in which Chang Yüe adapts to his purpose the Fu-nan version of asbestos in combination with the salamander story.

P. 351. The country Se-tiao appears in another text of the *I wu chi*, cited in the *Chêng lei pên ts'ao* (Ch. 23, fol. 49). There, a plant is briefly described under the name *mo-ch'ü* 摩廚 (according to G. A. STUART, *Chinese Materia Medica*, p. 499, unidentified), which grows in Se-tiao; the latter, it is added, is the name of a country. If it could be proved that *mo-ch'ü* is the transcription of a Javanese name (and this is probable), the case would make an interesting contribution to the identification of Se-tiao with Ye-tiao.



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Optical Lenses: I. Burning-Lenses in China and India

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OPTICAL LENSES.

BY

BERTHOLD LAUFER.



I. BURNING-LENSES IN CHINA AND INDIA.

FIRE-PRODUCTION BY MEANS OF OPTICAL LENSES AMONG THE ANCIENTS. — Crystal lenses, wherever employed in ancient times, served for one main purpose exclusively, — the optical method of fire-making. This method is not found among any primitive tribes of the world, but it is restricted to the highly advanced nations settled around the Mediterranean and to the peoples of India and China. W. HOUGH, in his interesting study *The Method of Fire-Making*,¹ has justly observed, "Among the several ways of producing 'pure' fire the mirror and lens presented a worthy method to those ancient cultured nations possessing instruments for focussing light. It can scarcely be said that this was a wide-spread and popular plan for producing fire, but probably was a thing known to priests and scientific men of the day, and viewed as a mystery or curiosity."

The centre of gravity of the following inquiry lies in a new research of this interesting subject, as far as China and India are concerned.² China and India, however, were not isolated in the age

¹ *Report of National Museum*, Washington, 1890, p. 408.

² This study owes its origin to a suggestion received from Dr. Frank Brawley and Dr. Emory Hill, two prominent oculists of Chicago, who are about to issue a comprehensive cyclopædia of ophthalmology, and desire to obtain reliable information on the history of optical lenses in Asia. The second part of this essay will deal with the history of spectacles.

when the utilization of lenses loomed up on their horizons, but partook of the blessings of that great world civilization inspired and diffused by Hellenism. This subject therefore, like all other culture-historical problems, must be visualized within the frame of universal history; and it will hence not be amiss first to pass in review what we know of burning-lenses among the ancients in the western part of the world.

The peoples of classical antiquity were acquainted with two optical instruments for the production of fire, — concave burning-mirrors and convex burning-lenses focussing the sunlight. The question as to whether these are to be attributed to the inventive genius of the Greeks, or were modelled by them on the basis of previous achievements of Mesopotamian civilization, cannot be decided in our present state of knowledge. H. LAYARD¹ (1845) discovered in the palace of the Assyrian King Ashur-naṣir-pal (885—860 B.C.) at Nineveh a rock-crystal lens of plano-convexity, $1\frac{1}{2}$ inches in diameter, with a focus of $4\frac{1}{2}$ inches, cut much like our own burning-glasses, though somewhat crude in its workmanship. It may well have performed the function of a burning-lens, as admitted by modern technologists;² but we should await more evidence before crediting the first invention of burning-lenses to the nations of the Euphrates Valley.

The earliest well-authenticated literary testimony for the use of burning-lenses remains the famous scene in Aristophanes' (c. 450—c. 385 B.C.) comedy *The Clouds* (Νεφέλαι), written in 423 B.C., where the following dialogue ensues between Strepsiades and Socrates (I quote from T. Mitchell's rendering).³

¹ *Discoveries among the Ruins of Nineveh and Babylon*, p. 197.

² NIEMANN and DU BOIS (in KRÄMER, *Der Mensch und die Erde*, Vol. VII, p. 162); and FELDHAUS, *Technik der Vorzeit*, col. 667.

³ The situation is this: Strepsiades, who has run up a debt of five talents, wants to dodge his obligation by destroying the bill of complaint recorded in wax by operating on it a burning-lens.

- STREPSIADES. I've hit the nail
That does the deed, and so you will confess.
- SOCRATES. Out with it!
- STREPSIADES. Good chance but you have noted
A pretty toy, a trinket in the shops,
Which being rightly held produceth fire
From things combustible —
- SOCRATES. A burning-glass,
Vulgarly call'd —
- STREPSIADES. You are right; 'tis so.
- SOCRATES. Proceed!
- STREPSIADES. Put the case now your bailiff comes,
Shows me his writ — I, standing thus, d'ye mark me,
In the sun's stream, measuring my distance, guide
My focus to a point upon his writ,
And off it goes in fumo!
- SOCRATES. By the Graces!
'Tis wittingly devis'd.

This translation is somewhat free, and does not bring out the technical points which are of importance for a consideration of the burning-lens. Strepsiades describes it as a beautiful and diaphanous stone (λίθος διαφανής ἀφ' ἧς τὸ πῦρ ἄπτουσι); and what Socrates in the above translation calls a burning-glass is in the Greek *hyalos* (ὑαλος). It is presumed that this word here appears for the first time in Greek literature in the sense of "glass,"¹ and accordingly that Aristophanes speaks of burning-lenses made from glass.² The reasons given in support of this opinion, however, are by no means convincing. The first Greek author with a distinct mention of glass is Herodotus (II, 69), who terms it "molten stone" (λίθος χυτή) with reference to the ear-rings placed by the Egyptians in the ears of their tame crocodiles. Herodotus (III, 24) likewise is the first to use the word ὑαλος in the description of the coffins of the Ethiopians, where it most evidently has the significance of "rock-crystal" or some other

¹ BLÜMNER, *Technologie*, Vol. IV, p. 384.

² M. H. MORGAN, *De ignis eliciendi modis apud antiquos* (*Harvard Studies in Classical Philology*, Vol. I, 1890, p. 46). This is the most complete study of Greek and Roman methods of fire-making, inclusive of burning-lenses and burning-mirrors.

transparent stone;¹ for "they put the prepared body in a crystal pillar hollowed out for this purpose, crystal being dug up in great abundance in their country."² If *ὕαλος* has in Herodotus, as shown by the inward evidence of the passage, the meaning of "rock-crystal," I see no reason why the same meaning should not be attributed to it in Aristophanes. Besides the passage cited, there is but one other in which the great writer of comedy makes use of the word: in *The Acharnians* the Greek ambassadors, returning from a mission to the King of Persia, report,

"At our reception we were forced to drink
Strong luscious wine in cups of gold and crystal,"³

as J. H. Frere translates with perfect correctness; where Blümner, Morgan, and others, however, see the first mention of glass vessels in Greek records.⁴ It seems to me more probable that gold and crystal vessels are here spoken of. In order to succeed in making the burning-lenses mentioned in *The Clouds* of glass, Morgan is obliged to have recourse to two theories which are unsupported by evidence. We see plainly from the words of Aristophanes, he observes, that glass was very rare in his time (while two pages ahead glass utensils were then at Athens), since he calls it a precious stone (*gemma*); and, as it is said that this stone is for sale in the shops of the pharmacists (*pharmacopola*), it is proved by this very fact that the matter was regarded as a miracle. This "miracle" will fade away, if we adopt the reasonable and natural interpretation of taking *ὕαλος* in this passage as "rock-crystal" with the specific sense of "burning-

¹ Some authors take it for Oriental alabaster or arragonite, which is transparent when cut thin.

² Thus also Achilles Tatius calls rock-crystal *ὕαλος δρῶνυγμένη*.

³ *Ἐξ ὑαλίνων ἐκπωμάτων*.

⁴ MORGAN (*l. c.*, p. 44) says with regard to this passage that glass utensils were at Athens as early as in Aristophanes' times; the passage, in my opinion, would allow only of the inference that they were at the Court of Persia, and dimly known to Aristophanes.

lens of crystal;"¹ and we are thus released from the necessity of making Aristophanes speak of glass as a precious stone. Strepsiades' description fits "crystal" very well indeed. There are other, historical reasons which warrant the belief that the first burning-lenses were cut from crystal, not from glass, as will be shown by a study of this subject from Chinese and Sanskrit sources.

M. H. MORGAN,² it is true, makes the point that rock-crystal became known only at a late period in classical antiquity, shortly before Augustus; and he reveals the Roman poet Helvius Cinna, and Strabo, who mentions the occurrence of crystals in India, as the earliest authorities. This opinion, however, is not correct. Rock-crystal (ἡ κρύσταλλος) is distinctly alluded to by Theophrastus (372—287 B.C.)³ as a translucent stone together with anthrax, omphax, and amethyst, all of which can be turned into signet-rings.

More important than the material of which the burning-lenses of the Greeks were made is the question as to their purpose and mode of use. The scene in Aristophanes' comedy enlightens us in this respect on two points. The effect of a burning-lens was perfectly known. The legal document of which Strepsiades speaks was certainly draughted on a tablet of wax, and related to a debt which he contracted; he intends to foil his creditors by melting the wax by

¹ This interpretation is adopted by LIDDELL and SCOTT in their *Greek-English Lexicon*.

² *Harvard Studies in Classical Philology*, Vol. I, pp. 44, 48—49.

³ *De lapidibus*, V, 80 (opera ed. WIMMER, p. 345, Paris, 1866). This fact is indicated also by KRAUSE (*Pyrgoteles*, p. 16) and SCHRADER (*Reallexikon*, p. 152). Theophrastus is the first Greek author to speak of rock-crystal. As is well known, the word κρύσταλλος occurs in Homer, but has the significance "ice" (derived from κρύος, "chill, frost"); an analogous example is presented by Hebrew *gerah* meaning "ice" and "rock-crystal." The actual utilization of the mineral is certainly much older than the allusions to it in literature. It occurs among the material listed for cylinder-seals in Mesopotamia (HANDCOCK, *Mesopotamian Archaeology*, p. 287) and among the intaglios of the Minoan, Mycenaean, and archaic Greek periods (D. OSBORNE, *Engraved Gems*, pp. 25, 283). On rock-crystal among the ancients, in general compare L. DE LAUNAY, *Minéralogie des anciens*, Vol. I, pp. 22—28; and C. W. KING, *Antique Gems*, pp. 90—97.

means of a burning-lens, and thus to escape judicial proceedings. Such action was not the order of the day, but the specific witty thought sprung by Strepsiades, at which Socrates laughs. The destruction of writs, therefore, was not the real object of burning-lenses; what they really were intended for we may infer from the allusion that they were kept in the shops of the pharmacists. At this point Morgan went somewhat astray by neglecting the statement of Pliny, quoted below, who assures us that crystal lenses were employed in medical practice for cauterizing the skin; and if the Chinese adopted this very same process, the chances are that also the druggists of Athens in the fifth century B.C. kept burning-lenses in stock, not for any fanciful, miraculous purpose, but with a somewhat realistic end in view, — to sell them as instruments useful in certain surgical operations. Cauterization was practised to a large extent in ancient times; and many forms of the cautery were devised, numerous specimens of which have survived.¹

THEOPHRASTUS, in his treatise on fire, mentions crystal, bronze, and silver, when wrought in a certain manner, as means of igniting fire.²

PLINY (23—79), in his *Natural History*, makes two references to burning-lenses, both of crystal and glass. In his chapter on crystal he says, "I find it stated in medical authors that crystal balls placed opposite to solar rays are the most useful contrivance for cauterizing the human body."³ It will be noticed that the Chinese physicians

¹ J. S. MILNE, *Surgical Instruments in Greek and Roman Times*, pp. 116—120. Milne (p. 5) asserts, "The writings of Pliny contain little information of any kind and are absolutely of no use for our purpose;" but Pliny's references to burning-lenses, quoted above, would have found a suitable place in his chapter on canteries, and assisted in enlightening the text of Hippocrates on p. 120.

² Ἐξάπτεται δὲ ἀπὸ τε τῆς ὑέλου καὶ ἀπὸ τοῦ χαλκοῦ καὶ τοῦ ἀργύρου τρόπον τινὰ ἐργαζόμενων (*De igne*, 73; opera ed. WIMMER, p. 363). Others cancel the words ἀπὸ τε τῆς ὑέλου and interpret the instruments as concave mirrors (MORGAN, *l. c.*, p. 52).

³ Invenio apud medicos, quae sint urenda corporum, non aliter utilius uri putari quam crystallina pila adversis opposita solis radiis (xxxvii, 10, § 28).

made use of crystal lenses for exactly the same purpose. In the other passage it is remarked, "If glass balls filled with water are exposed to sunlight, they produce such a vigorous heat that they will ignite clothes." ¹

LACTANTIUS, the eminent Christian author of the third and fourth centuries, apparently under Pliny's influence, writes that when a glass globe full of water is held in the sun, fire will spring from the light reflected from the water, even in the severest cold. ²

ISIDORUS, the learned Bishop of Sevilla (570—636), observes that crystal opposed to solar rays attracts fire to such a degree that it ignites arid fungi or leaves. ³ His knowledge is evidently based on Pliny.

Besides the passages in Pliny we find a clear mention of crystal lenses in the *Orphica*, or *Λισιζά* of Orpheus, — a Greek poem wrongly associated with the name of Orpheus, and describing the magical properties believed to be inherent in stones, and revealed by the seer Theodamas to Orpheus. It is not, as formerly assumed, a work coming down from around 500 B.C., ⁴ but it manifestly bears the ear-marks of the late Alexandrian epoch, and is a production of post-Christian times. Crystal opens the series of stones dealt with in this work (Verses 170—184). The deity cannot resist the prayers of him who, bearing in his hand a refulgent and transparent crystal, betakes himself into a temple: his wish will surely be granted. When crystal

¹ Cum addita aqua vitreae pilae sole adverso in tantum candescant, ut vestes exurant (xxxvi, 67, § 199).

² Orbem vitreum plenum aquae si tenueris in sole, de lumine quod ab aqua refulget ignis accenditur etiam in durissimo frigore (*De ira Dei*, x).

³ Hic (crystallus) oppositus radiis solis adeo rapit flammam ut aridis fungis vel foliis ignem praebeat (*Origines*, xvi, 13, 1). Fungi used in cauterization are mentioned by Hippocrates and Paul.

⁴ KRAUSE, *Pyrgoteles*, p. 6. The exact date of this work is not satisfactorily established (compare BERNHARD, *Grundriss d. griech. Lit.*, Vol. II, pt. 1, p. 359; and SUSEMIHL, *Gesch. d. griech. Lit. in der Alexandrinerzeit*, Vol. I, p. 866).

is placed on dry wood-shavings, while the sun-rays strike it, smoke will soon arise, then fire, and at last a bright flame, regarded as sacred fire. No sacrifice is more pleasing to the gods than when offered by means of such fire.

The ancients, accordingly, employed optical lenses in medicine for cauterizing the skin, and in the religious cult for securing sacred fire. The opinion has been expressed also that they served the purpose of magnifying objects, with reference to a passage in SENECA, that letters, however minute and indistinct, appear larger and clearer through a glass ball filled with water.¹ LESSING² has ingeniously and conclusively demonstrated that there is a wide step from a magnifying-sphere to a magnifying-lens, and that the causes of the enlargement were sought by the ancients, not in the spherical shape of the glass, but in the water with which it was filled. Moreover, the passage of Seneca proves nothing beyond a personal experience of that author; and there is, in fact, no ancient tradition regarding specular or magnifying lenses. In Pompeii, Nola, and Mainz, lenses have been excavated, of which J. MARQUARDT³ says that they could have been nothing but magnifying-lenses. I am unable to admit the force of this conclusion, and think that these lenses were simply burning-lenses.⁴

BURNING-LENSES IN THE MIDDLE AGES AND AMONG THE ARABS.—The European middle ages are doubtless indebted to the ancients for whatever knowledge of this subject then existed. The mineralogical knowledge of this period is mainly based on the important work of

¹ *Litterae quamvis minutae et obscurae per vitream pilam aqua plenam maiores clarioresque cernuntur (Quaestiones naturales, i, 6, 5).*

² *Briefe, antiquarischen Inhalts*, No. 45.

³ *Privatleben der Römer*, p. 752.

⁴ M. H. MORGAN (*Harvard Studies in Classical Philology*, Vol. I, 1890, p. 46) sides with Marquardt and Sacken against Lessing, but on insufficient grounds, and evidently without taking serious notice of Lessing's forcible arguments.

the French Bishop of Rennes, MARBODUS (1035—1123), entitled *De lapidibus pretiosis*, and written in Latin hexameters. This poem, largely founded on Pliny, Solinus, and the Orphica, conveyed the classical traditions regarding stones to mediæval Europe, became the direct source of at least four French *Lapidaires*, and successfully maintained its place as the great pedagogical manual on precious stones and as the classical handbook of the schools of pharmacy down to the end of the sixteenth century.¹ In § 41 of his work, Marbodus makes the following observation on crystal lenses:

“But true it is that held against the rays
Of Phœbus it conceives the sudden blaze,
And kindles tinder, which, from fungus dry
Beneath its beam, your skilful hands apply.”²

As regards the further development of this matter, suffice it for our purpose to quote from KONRAD VON MEGENBERG'S (1309—78) *Book of Nature*, — “If the sun shines on a round crystal, it ignites tinder in like manner as the beryl does; if it is round like an apple, and if it is exposed to the sun while it is moist, it ignites extinguished coal,” — and to refer to the *Opus maius* of ROGER BACON (1240—92),³ who attempted to analyze the operation of a burning-lens. But Bacon's essay is dependent on that of the Arabic physicist Ibn al-Haiṭam (or Alhazen, 965—1039), who treated the problem much more profoundly and scientifically.⁴

¹ Compare the interesting discussion of L. PANNIER, *Lapidaires français du moyen âge*, pp. 15 *et seq.* (Paris, 1882).

² Translation of C. W. KING, *Antique Gems*, p. 411. In the earliest French translation (PANNIER, *l. c.*, p. 61) this passage runs thus: “Ceste conceit le fou vermeil, | Ki la tient el raî del soleil, | E de cel fou li tondre esprent | S'il i tuchet alques sovent.”

³ *The “Opus maius” of Roger Bacon*, ed. by J. H. BRIDGES, Vol. I, p. 113 (Oxford, 1897).

⁴ Compare S. VOGL, *Physik Roger Bacos*, p. 80. — In regard to the more recent employment of burning-lenses, it is said that some Old-English tobacco-boxes have a lens in the lid for use on emergency; and naturalists still make occasional use of their pocket-lenses as a substitute for a match (*Horniman Museum and Library, Handbook on Domestic Arts*, I, p. 35).

Arabic knowledge of crystal lenses, again, is founded on that of classical authors, and mainly linked with the name of Dioscorides. In the Arabic version of the *Materia Medica* of this Greek author, compiled by Ibn al-Baiṭār (1197—1248), we find it stated that rock-crystal struck by hardened iron yields abundant sparks;¹ that a piece of black linen subjected to the rays emitted by this stone, when it is exposed to solar light, will be ignited and consumed; and that it may be employed in this manner in order to obtain fire.² The Arabic *lapidarium* of the ninth century, traditionally but wrongly ascribed to Aristotle, mentions the sparks of crystal in the same manner, but omits the reference to lenses, which, however, occurs in the Hebrew and Latin translations of the same work.³ Qazwīnī, the Arabic encyclopædist of the thirteenth century (1203—83), observes, "If rock-crystal is placed opposite the sun, and if a black rag or a flake of cotton is brought near it, the latter will catch fire, and objects may be lighted with such fire. There is still another kind of rock-crystal, less pure than the former, but harder; whoever beholds it, takes it for salt. If struck with hardened steel, however, sparks will easily spring from it; hence it serves as strike-a-light for the men of the kings."⁴

¹ The ancient Laplanders made ample use of rock-crystal in the place of flint, and an eye-witness who tried the experiment assures us that rock-crystal struck by the steel yields more sparks than flint (J. SCHEFFER, *Lappland*, p. 416, Frankfurt, 1675). Also in the prehistoric ages of northern Europe, quartzites served for the production of fire (compare the interesting study of G. F.-L. SARAuw, *Le feu et son emploi dans le nord de l'Europe aux temps préhistoriques*, in *Annales du XXe Congrès archéol. et hist. de Belgique*, Vol. I, Gand, 1907, pp. 196—226, chiefly, pp. 213 *et seq.*).

² L. LECLERC, *Traité des simples*, Vol. III, p. 342.

³ RUSKA, *Steinbuch des Aristoteles*, pp. 170, 171. The Latin text runs thus: "Bonitas huius lapidis est quod quando exponitur soli rotundatus ut radii solares penetrent ipsum erit ignis ab eo" (*ibid.*, p. 207). The word *rotundatus* denotes a burning-lens.

⁴ RUSKA, *Steinbuch aus der Kosmographie des al-Qazwīnī*, p. 9. E. WIEDEMANN (*Sitzungsberichte der phys.-med. Soz. Erlangen*, Vol. 36, 1904, p. 332) remarks that the Arabic author omitted the word "globe" after "rock-crystal;" and he thinks it notable that Qazwīnī expressly speaks of rock-crystal.

Likewise in their knowledge of burning-mirrors, the Arabs depend upon the science of the Greeks, as shown in their discussions of this subject by references to Anthemius and Diocles.¹

REFUTATION OF THE THEORIES THAT THE ANCIENT CHINESE WERE ACQUAINTED WITH BURNING-LENSES. — In passing on to China, we face a bewildering jungle of speculations and opinions as to our subject; and only after clearing this jungle will it be possible to discuss the real facts in the case. If Dr. E. HILL² recently stated that "it is said that a Chinese emperor used lenses as early as 2283 B.C. to observe the stars," we here find expression of that popular opinion which credits the Chinese with lenses prior to the Greeks, — an invention which, as will be seen, was never made by the Chinese themselves. A lens could not have been manufactured at that time, as the materials required for it, glass or rock-crystal, were then unknown in China. Moreover, the Chinese in this case lay no claim whatever to a lens. The text from which this alleged lens (I do not know by whom) has been distilled is contained in the oldest historical record of the Chinese, the *Shu king* (II, 5), in which the astronomical activity of the Emperor Shun is spoken of: he is said to have availed himself of an instrument of jade, the description of which is not given in the text, but only by the late commentators.³ Whatever this instrument of hard, untransparent stone may have been, it surely has nothing in common with a lens.

Even professional sinologues, like SCHLEGEL,⁴ and quite recently FORKE,⁵ have asserted that burning-lenses were known to the Chinese

¹ WIEDFMAN, *Sitzungsberichte der phys.-med. Soz. Erlangen*, Vol. 37, 1905, p. 402.

² *Ophthalmic Record*, Vol. 23, 1914, p. 504.

³ See LEGGE, *Chinese Classics*, Vol. III, p. 33; COUVREUR, *Chou king*, p. 14; CHAVANNES, *Mémoires historiques de Se-ma Ts'ien*, Vol. I, pp. 58—59; and the writer's *Jade*, pp. 104 *et seq.*

⁴ The views of Schlegel are discussed farther on.

⁵ *Lun-hêng*, pt. 2, pp. 496—498.

in pre-Christian times long before they were known to the Greeks. Their conclusions, however, rest on a fallacy due to misunderstandings of the texts. We shall closely examine these, and see how those scholars were prompted to their opinions. It will be demonstrated at the same time that optical lenses of crystal or glass were absolutely unknown in China prior to our era.

Se-ma Chêng of the eighth century A.D. records, in his *Memoirs of the Three Early Sovereigns* (*San huang ki*), the following legend regarding the mythical being Nü-kua or Nü-wa, conceived as a serpent with a human head: ¹ "He fought with Chu-yung [the regent of fire] and failed in victory. Flying into a rage, he butted with his head against Mount Pu-chou and brought it down. The pillar of heaven was broken, and the corners of earth were bursting. Nü-kua then fused five-colored stones to repair the firmament, and cut off the feet of a marine tortoise to set up firmly the four extremities of earth. He gathered the ashes of burnt reeds to stop the inundation, and thus rescued the land of Ki. Thereupon the earth was calm, the sky made whole, and the old order of things remained unchanged." ² The same tradition is contained in the book going under the name of the alleged philosopher Lie-tse, ³ the present recension of which, in all probability, is not earlier than the Han period; likewise in the book of Huai-nan-tse of the second century B.C., ⁴ and in the *Lun-hêng* of Wang Ch'ung. ⁵ The latter philosopher points it out as a very ancient tradition believed by most people.

¹ Originally a male sovereign, but from the second century A. D. represented on the bas-reliefs of the Han period as a woman.

² Compare CHAVANNES, *Mémoires historiques de Se-ma Ts'ien*, Vol. I, pp. 11, 12; H. J. ALLEN, *Ssüma Ch'ien's Historical Records* (*Journ. Roy. As. Soc.*, 1894, p. 274); MAYERS, *Chinese Reader's Manual*, p. 162; HIRTH, *Ancient History of China*, p. 11.

³ Ch. 5, *Tang wén* (compare E. FABER, *Naturalismus bei den alten Chinesen*, p. 104; L. GILES, *Taoist Teachings from the Book of Lieh Tzŭ*, p. 85; L. WIEGER, *Les pères du système taoïste*, p. 131).

⁴ *P'ei wên yüen fu*, Ch. 21, p. 217.

⁵ A. FORKE, *Lun-hêng*, pt. 1, p. 250; pt. 2, p. 347.

Every unbiased student will recognize in this legend concerning Nü-kua a genuine myth, in which a cosmological catastrophe is hinted at, the havoc wrought to heaven and earth being repaired with realistic expedients contrived by a primitive and naïve imagination. He whose trend of mind is bent on interpretation may fall back on the phenomenon of the rainbow, which may have impressed a primitive mind as consisting of stone-like patches for mending the sky after the destructive force of a rainstorm; and the brilliant colors of a quartz or agate may have intimated an association of ideas between the hues of a stone and those of the iris. The composite coloration of a stone may have suggested the effect of a smelting-process; at all events, the molten stones of a legend cannot be taken literally; the casting of metal is naïvely transferred to stones. Be this as it may, or whatever our interpretation of the myth may drive at, it is obvious to every sober mind that the elements of a fantastic myth, which is not reducible to an analysis of actual reality, cannot be utilized as the foundation of far-reaching conclusions as to industrial achievements of the Chinese. Some of our sinologues, however, were of a different opinion. The melting of the five-colored stones ascribed to that fabulous being was a rather tempting occasion for the exercise of ingenious speculations. MAYERS¹ championed the idea that the stone of five colors is coal, the useful properties of which Nü-kua was the first to discover; and T. DE LACOUPERIE,² in a very interesting article, took great pains to demonstrate that the legend has nothing to do with the introduction of glass and the discovery of mineral coal, though by no means himself arriving at any positive result.

Wang Ch'ung,³ in connection with a fire-making apparatus for

¹ *Notes and Queries on China and Japan*, Vol. II, p. 99.

² *T'oung Pao*, Vol. II, 1891, pp. 234—243.

³ *Lun hêng*, Ch. 16, p. 2 (ed. of *Han Wei ts'ung shu*). FORKE, *Lun-hêng*, pt. 2, p. 351.

drawing fire from the sky, mentions the practice, that "on the day *ping-wu* of the fifth month, at noon, they melt five stones to be cast into an instrument that is capable of obtaining fire." According to FORKE,¹ Wang Ch'ung speaks of burning-glasses as, "The material must have been a sort of glass, for otherwise it could not possess the qualities of a burning-glass."² Flint glass, of which optical instruments are now made, consists of five stony and earthy substances, — silica, lead oxide, potash, lime, and clay. The Taoists, in their alchemical researches, may have discovered such a mixture." By interpreting the terms *yang sui* 陽燧 or *fu sui* 夫遂 as "burning-glass," Forke reads of burning-glasses even in the *Chou li*, and is finally carried to this conclusion: "Burning-reflectors were known to the Greeks. Euclid, about 300 B.C., mentions them in his works; and Archimedes is believed to have burned the Roman fleet at Syracuse in 214 B.C. with these reflectors, — probably a myth. Plutarch, in his life of Numa, relates that the Vestals used to light the sacred fire with a burning-speculum. As the *Chou li* dates from

¹ *Ibid.*, p. 496.

² It will be seen below that this conclusion is a fallacy, and is in fact inadmissible; but, granting for a moment its *raison d'être*, the technical point is not so easily settled, as represented by Forke. Wang Ch'ung does not speak of five different stones, but, as demonstrated farther on, indeed speaks of five-colored stones with a distinct allusion to the Nü-kua legend; his term *wu shi* 五石 in this passage being merely a loose expression or abbreviation for *wu se shi* 五色石. If, then, a multi-colored stone is here in question, and if this stone could be identified with a kind of quartz, Forke's opinion, from a technical point of view, would not be utterly wrong; for it is technically possible to make glass from quartz. This experiment was successfully carried on about a decade ago by C. Heræus in Hanau: the quartz utilized was melted in vessels of pure iridium, which melts at 2000°, while the melting-point of quartz is at 1700°. After exceeding its melting-temperature, the quartz becomes glassy. The process itself is difficult and complex, and it would be unreasonable to suppose that a technical manipulation which has succeeded only in our own time should have been familiar to the ancient Chinese, who derived from the West whatever knowledge of glass they possessed. If, however, the "five-colored stone," as shown below, was a variety of agate or soapstone (and this opinion is highly probable), nothing remains of Forke's theory.

the eleventh century B.C. (?), it is not unlikely that the Chinese invented the burning-reflector independently, and knew it long before the Greeks."

TH. W. KINGSMILL once remarked,¹ "Myths have been not inaptly described by Max Müller as a disease of language; and to this category we may perhaps relegate the group of modern myths which have grown up in and around our descriptions of China and its arts." I apprehend that the assigning to the ancient Chinese of burning-lenses belongs to this category of modern myths based on mis-interpretation of terms. BIOT,² SCHLEGEL,³ HIRTH,⁴ and CHAVANNES⁵ have clearly shown that the fire-apparatus spoken of in the *Chou li* was a metal mirror, and the Chinese commentators claim no more for it; even Forke cites their opinion, yet mechanically clings to his idea of burning-glasses. Unfortunately, he omits to tell us how the Chinese of the Chou period — when even a word for "glass," and certainly the matter itself, were unknown to them — should have obtained glass. And if the molten stones of Wang Ch'ung, in Forke's opinion, are glass, the molten colored stones of Nü-kua would be entitled to the same consideration; and thus the baffling result would be attained that not only burning-glasses, but also glass in general, are truly Chinese inventions, the latter going back to the dim past of prehistoric ages.

An intimation that the five-colored or variegated stone is a reality, is first given by Li Tao-yüan 麗道元, who died in A.D. 527, in his commentary on the *Shui king* 水經注, a book on the rivers of China:⁶ "On the northern side of the Hen Mountains, along the

¹ *Chinese Recorder*, Vol. VII, 1876, p. 43.

² *Le Tcheou-li*, Vol. II, p. 381.

³ *Uranographie chinoise*, p. 612.

⁴ *Boas Anniversary Volume*, pp. 226—227.

⁵ *Le T'ai Chan*, pp. 188—189.

⁶ Compare CHAVANNES, *T'oung Pao*, 1905, p. 563.

Ki River, the rocky hills border the river so closely that there is no space for flat beaches; in places where the water is shallow there is plenty of five-colored stones."¹ In another passage he refers to carvings from the stone of the same name, which served for the decoration of a palace of the Emperor Wên of the Wei dynasty in A.D. 220.

The *Yün lin shi p'u* 雲林石譜 by Tu Wan 杜綰 of 1133² likewise makes mention of five-colored stones 五色石 in the Ki River 溪水 near Sung-tse 松滋, in the prefecture of King-nan 荆南府 (now King-chou), in the province of Hu-peï. Among these are some almost transparent, intersected by numerous lines that are straight like the fibres of a brush, and not different from the agate of Chên-chou 眞州.³

Another tradition crops out in the Gazetteer of Lai-chou 萊州志,⁴ according to which the district of Ye 掖縣, forming the prefectural city of Lai-chou on the northern coast of Shan-tung, would produce five-colored stones made into vessels and dishes, and asserted to be identical with the "strange stones" (*kuai shi* 怪石) mentioned in the Tribute of Yü.⁵ This stone of Lai-chou is well

¹ 徂山北溪水所經皆石山略無土岸。其水淺處多五色石 (*P'ei wên yün fu*, Ch. 100 A, p. 16).

² Ch. B, p. 5^b (edition of *Chi pu tsu chai ts'ung shu*).

³ The latter is found in the water or sandy soil of the district Liu-ho 六合, in the prefecture of Kiang-ning, province of Kiang-su. According to Tu Wan's description, this agate is either a pure white or five-colored, the latter variety being characterized by the same attributes as the stone of Sung-tse; it is locally used for the carving of Buddhist images.

⁴ *P'ei wên yün fu*, Ch. 100 A, p. 16.

⁵ LEGGE, *Chinese Classics*, Vol. III, pp. 102, 104; COUVREUR, *Chou king*, p. 67; compare *Ts'ien Han shu*, Ch. 28 A, p. 1_b. Legge remarks that the "strange stones" are very perplexing to the commentators, and that Ts'ai gets over the difficulty by supposing they were articles indispensable in the making of certain vessels, and not curiosities, merely to be looked at. The above identification seems to me very plausible; on account of its numerous shades and curious designs, in which the imagination of the Chinese sees grotesque scenery, the soapstone of Lai-chou could well have merited the name "strange or supernatural stone."

known to us; it is a variety of agalmatolite or soapstone which is still carved by the Chinese into a hundred odds and ends and worked up into soap, the stone being powdered, and the powder being pressed into forms.¹ Its tinges are manifold and very pleasing, and are therefore capable of artistic effects. The Field Museum owns several albums of the K'ien-lung period, containing pictures (人物) entirely composed of Lai-chou stone of diverse colors, neatly cut out and mounted. The stone being very soft, carving is comparatively easy.²

We accordingly note that in post-Christian times the "five-colored stone" has been identified by the Chinese with a variety of either agate or soapstone. This certainly does not mean at the outset that the stone of the same designation attributed by tradition to times of great antiquity must be identical with one or the other; the ancient name *wu sé shi*, whatever it may have conveyed in its origin, may simply have been transferred to certain kinds of agate and soapstone in comparatively recent periods. This stricture being made, however, there remains a great deal of probability that the five-colored stone of Nü-kua, after all, was nothing else; there is, at least, no valid reason why it should have been something else.³ To this interpretation, Forke might object that in the aforesaid passage of Wang Ch'ung the question is not of the melting of five-colored stones, as in the tradition of Nü-kua, but of the melting of five

¹ F. v. RICHTHOFEN, *Schantung*, pp. 199—200; A. WILLIAMSON, *Notes on the Productions of Shan-tung* (*J. China Branch R. As. Soc.*, Vol. IV, 1868, p. 69); BECHER, *Notes on the Mineral Resources of Eastern Shan-tung* (*ibid.*, Vol. XXII, 1888, p. 37); A. FAUVEL, *The Province of Shantung* (*China Review*, Vol. III, 1875, p. 375).

² It is described in the *Yün lin shi p'u*, Ch. B, p. 1^b.

³ T. DE LACOUPERIE (*T'oung Pao*, Vol. II, p. 242) based his theory of five-colored stones on certain geological conditions of Shan-si Province, where, according to A. Williamson, the strata of some hillsides are clearly marked from base to summit, the many-colored clays presenting all the hues of the rainbow. This would not be so bad if the Chinese accounts really spoke of clay; but they obstinately insist on stones, and stone and clay were strictly differentiated notions also to the ancient Chinese.

single stones, and that consequently the aspect of the problem is thus modified; this objection, however, could not be upheld. The solution of the problem is furnished by Wang Ch'ung himself. In two passages of his work, as already pointed out, he himself narrates the tradition regarding Nü-kua, and his mending of the sky by means of five-colored stones. At the end of the chapter,¹ in which he subjects the story to a lengthy discussion, scorning it with ruthless sarcasm, he suddenly changes his phraseology, and speaks of "the repairing of the sky by means of five kinds of stones, which may have worked like medicinal stones in the healing of disease."² Consequently in the diction of the author the two terms "five-colored stone" (*wu sé shì*) and "five stones" (*wu shì*) are interchangeable variants relating to the same subject-matter. It is therefore evident beyond cavil that the passage concerning the fire-apparatus, where the fusing of five stones is mentioned, likewise implies a literary allusion to the Nü-kua legend, and refers to exactly the same affair. If glass is not involved (nor can it be intended) in the Nü-kua legend, it cannot, accordingly, be sought for either, as alleged by Forke, in this passage of Wang Ch'ung.

The question now remains to be answered, Why does Wang Ch'ung bring stones on the tapis to describe an instrument which, judging from all other Chinese records, was a metal mirror? We know that the ancient Chinese possessed mirrors of stone. HIRTH³ has indicated a jade mirror found in A.D. 485 in an ancient tomb near Siang-yang in Hu-pei Province, which the polyhistor Kiang Yen (443–504) stated to date from the time of King Sūan (827–782 B.C.). The *Yün lin shì p'u*⁴ mentions two localities where stone material fit for mirrors was quarried, — Mount Wu-ki 悟溪山, in the district

¹ FORKE, *Lun-héng*, pt. 1, p. 252.

² This passage is quoted also in *P'ei wén yün fu*, Ch. 100 A, p. 16.

³ *Chinese Metallic Mirrors* (Boas Anniversary Volume, p. 216).

⁴ Ch. c, p. 9.

of K'i-yang 祁陽, prefecture of Yung-chou 永州, province of Hu-nan, the stone slabs of which, several feet wide, of deep blue (or green) hue, could reflect objects at a distance of several tens of feet; and the district of Lin-ngan 臨安, in the prefecture of Hang-chou 杭州, province of Chê-kiang. In Su-chou, such stone mirrors, usually carved from Yün-nan marble (*Ta-li shi* 大理石), are still offered for sale. When we now critically analyze the passage of Wang Ch'ung, we recognize in it a fusion of three different notions, — first, the alleged melting of stones borrowed from the Nü-kua legend; secondly, a recollection of stone mirrors looming up in his mind; and, thirdly, a reminiscence of metal mirrors used in the Chou period (and also subsequently) for securing fire. In a word, his description is a downright literary concoction, pieced together from three different sources; and it is therefore impossible to regard it as an authentic and authoritative source from which any conclusions as to realities may be derived. It can prove absolutely nothing for the elucidation of facts, such as glass, burning-glasses, burning-mirrors, or anything else. Forke's thesis of the alleged priority of the Chinese in the matter of burning-glasses is untenable; and the fact remains, much more solidly founded than assumed by Forke, that the ancients were the first to make use of them.¹

Another weapon, seemingly still more formidable, has been introduced into the discussion by Schlegel. Liu Ngau, commonly known under the name Huai-nan-tse, a member of the imperial family, philosopher and alchemist, who died in 122 B.C., is credited by SCHLEGEL² with the statement that "it is not absolutely necessary

¹ Forke has not clearly discriminated between burning-lenses and burning-mirrors. I hope to devote a monograph to the latter subject with particular reference to the relation of the Greek burning-mirrors to the Chinese. So much may be said here that Greek priority seems to me to be established along this line also.

² *Uranographie chinoise*, p. 142; and *Nederlandsch-Chineesch Woordenboek*, Vol. I, p. 674.

to employ a bright metal plaque, but that a large crystal ball likewise, held toward the sun, can produce fire." Consequently burning-lenses should have been known to the Chinese in the second century B.C. This would indeed be very nice, were it not that Huai-nan-tse never made such an assertion, wrongly attributed to him by Schlegel. Of all that Schlegel makes him say, he has in fact said only the very first sentence,—"When the mirror is held toward the sun, it will ignite and produce fire,"—while all the rest of it does not emanate from the philosopher, but from his later commentators. Schlegel, indeed, does not quote Huai-nan-tse's original text, but derives the passage from a recent work, *Liu ts'ing ji cha* 留青日札.¹ We need only refer, however, to Huai-nan-tse's actual text,² to recognize at a glance the real state of affairs. Huai-nan-tse knew only of concave metal mirrors for the production of fire, but nothing whatever about crystal or any other lenses. He repeatedly mentions the former,³ but never the latter, nor does any of his contemporaries, for the reason that lenses did not turn up on the horizon of the Chinese before the beginning of the seventh century A.D.⁴

BURNING-LENSES NOT A CHINESE INVENTION. DEFICIENT KNOWLEDGE OF THE SUBJECT ON THE PART OF THE CHINESE. — China has indeed known lenses, and certain optical properties of them; yet they were not invented by the Chinese, but were received and introduced by them from India. This fact will be established by the investigation to follow. The subject is somewhat complex, and has never been clearly set forth by any author, Chinese or foreign. It is indispensable to penetrate into the primeval sources, and to sift their

¹ A collection of miscellaneous essays by T'ien Yi-hêng, a writer of the Ming period.

² Ch. 3, p. 2 (edition of *Han Wei ts'ung shu*). In the commentary of this edition no reference is made to crystal lenses; their mention is simply an utterance of the author of *Liu ts'ing ji cha*.

³ For instance, Ch. 5, pp. 11, 14; Ch. 6, p. 2^b; Ch. 8, p. 1^b; etc.

⁴ Another argument of Schlegel in favor of early Chinese acquaintance with burning-lenses is discussed below in the paragraph on ice-lenses.

data with critical eyes, as the recent Chinese writers have been unable to cope with the matter properly; at any rate, none of their statements can be accepted without careful examination. Li Shi-chên, the great Chinese authority on physical science in the sixteenth century, who spent a lifetime on the elaboration of his praiseworthy work *Pên ts'ao kang mu*, has summarized his knowledge of optical lenses (*huo chu* 火珠, "fire-pearls") as follows:¹ "The dictionary *Shuo wên* designates them as 'fire-regulating pearls' (*huo-ts'i-chu* 火齊珠).² The Annals of the Han Dynasty style them *mei-hui* 玫瑰, these characters having the sounds *mei hui* 枚回. The Annals of the T'ang Dynasty narrate that 'in the south-eastern ocean there is the Lo-ch'a country 羅刹國 producing fire-regulating pearls, the biggest of these reaching the size of a fowl's egg, and in appearance resembling crystal 水精. They are round and white, and emit light at a distance of several feet. When exposed to the sunlight, and mugwort is placed near, the latter is ignited.' Such lenses are used in the application of moxa, which in this manner is painless.³ At present there are such lenses in Champa (Chan-ch'êng 占城), which are styled 'great fire-pearls of the morning dawn' (*chao lia ta huo chu* 朝霞大火珠). The *Sü Han shu* 續漢書⁴ says that the country of the Ai-lao barbarians⁵ pro-

¹ *Pên ts'ao kang mu*, Ch. 8, p. 18. This notice is an appendix to his account of rock-crystal.

² This translation and its meaning will be explained in the following section. We have no adequate word to cover exactly the meaning of Chinese *chu* 珠, which means not only a "bead" or "pearl," but also a "gem or precious stone," usually of circular shape. Already d'HERBELOT (*Bibliothèque orientale*, Vol. IV, p. 398) has explained correctly these various shades of meaning.

³ This sentence is not contained in the T'ang Annals, but is Li Shi-chên's own statement. For explanation see below.

⁴ A continuation of the official history of the Han dynasty, written by Sie Ch'êng 謝承 of the third century.

⁵ 哀牢夷. These tribes (their Chinese designation is preserved in the name "Laos") formed the Shan kingdom, first appearing in history during the first century of our era, in the present territory of Sze-ch'uan and Yün-nan.

duces stones styled *huo-tsing* 火精 ('fire-essence') and *liu-li* 琉璃. In view of this fact, the term *huo-ts'i* 火齊 is an error for *huo-tsing* 火精; the latter is correct in correspondence with the term *shui-tsing* 水精 ('water-essence,' a name for rock-crystal)."¹ It will be seen from the following discussion that this notice is very inexact in detail, and altogether highly uncritical, — a defect for

¹ F. DE MÉLY (*Lapidaires chinois*, p. 60), who has partially translated this text (not from the original, but from a late Japanese cyclopædia), gives wrong characters and transcriptions of the Chinese terms, — *kiu koei* instead of *mei hui* (or *mei hwei*, or *mei kwei*; see farther below), and *ho chai* in lieu of *huo ts'i*. Moreover, the rendering of *huo chu* by "lupe" is inadmissible, as neither the Chinese nor the Indians have ever made use of magnifying-lenses, but both peoples were familiar only with lenses for fire-making. — The term *huo-tsing* is not an error for *huo-ts'i*, as assumed by Li Shi-chên, but denotes a red variety of rock-crystal supposed to attract fire, while the white variety of the same stone attracts water and fire at the same time (*Wu li siao shi*, Ch. 7, p. 13^b); *huo-tsing* and *huo-ts'i*, in fact, refer to different minerals. In the same manner as among the ancients, the speculations of the Chinese concerning the nature of rock-crystal were divided between the opinions that, on the one hand, it was the essence of water (owing to the outward resemblance to ice) and, on the other hand, the essence of fire (because when struck with steel, it yields sparks, or when used as a lens, produces fire). HIRTH (*China and the Roman Orient*, p. 233) is quite right in deriving the former theory from classical lore. I hope to come back to this subject in detail in a series of studies dealing with Chinese-Hellenistic relations. In opposition to PLINY (XXXVII, 9, § 23), who takes crystal for a kind of ice due to excessive congelation, found only in regions where the winter snow freezes most intensely (*Contraria huic causa crystallum facit, gelu vehementiore concreto. Non aliubi certe reperitur quam ubi maxime hibernae nives rigent, glaciemque esse certum est, unde nomen Graeci dedere*), DIODORUS SICULUS of the first century B. C. expresses the view that crystal originates from purest water hardened into ice, not by cold, however, but through the powerful effect of solar heat (*Crystallum ex aqua purissima in glaciem indurata coalescere aiunt, non quidem a frigore, sed divini ignis potentia*). The celebrated French Bishop MARBODUS (1035—1123) attacked the glacial theory in his poem *De lapidibus pretiosis* (§ 41) as follows: "*Crystallus glacies multos durata per annos, | Ut placuit doctis, qui sic scripsere, quibusdam, | Germinis antiqui frigus tenet atque colorem. | Pars negat, et multis perhibent in partibus orbis | Crystallum nasci, quod non vis frigoris ulla, | Nec glacialis hiems unquam violasse probatur.*" In China, the same theory was called into doubt by Ts'ao Chao 曹昭 in his *Ko ku yao lun* 格古要論, published in 1387: "Although it is said that many years old ice becomes rock-crystal, this is obviously false in view of the fact that green and red crystals occur in Japan" (多年老冰爲水晶然日本國有青水晶紅水晶則水晶非冰也明矣), — an attempt at scientific thinking.

which Li Shi-chên himself is not solely responsible, but which already adheres to his uncritical predecessors. We note, first of all, that he avails himself indiscriminately of three terms, — *huo chu* ("fire-pearl"), *huo-ts'i-chu* ("fire-regulating pearl"), and *mei-hui*. On a previous occasion I ventured to express doubts of the alleged identity of the former two terms;¹ and it will now be demonstrated that they indeed relate to two different mineral substances associated by the early Chinese accounts with two different traditions. In fact, neither the *Shuo wên* nor the Han Annals speak of burning-lenses; Li Shi-chên, however, is quite correct in tracing them to the Lo-ch'a country, but cites the T'ang Annals wrongly by assigning to them the term *huo ts'i chu* instead of *huo chu*. This text of the T'ang Annals indeed is the first and earliest authentic Chinese account relative to burning-lenses. We note also that Li Shi-chên does not claim any knowledge of them on the part of Wang Ch'ung or Huai-nan-tse; and, as far as I know, there is no Chinese author who would make such a pretension. The various problems raised by the text of the *Pên ts'ao kang mu* will now be discussed in detail.

HUO-TS'I NOT A BURNING-LENS, BUT MICA. — The earliest definition of the "fire-regulating pearl" (*huo ts'i chu* 火齊珠)² that occurs

¹ *Notes on Turquois in the East*, p. 28.

² HIRTH and ROCKHILL (*Chau Ju-kua*, p. 113) express the opinion that *huo ts'i* appears to be a foreign word, without being able, however, to indicate for which foreign word it might be intended. This supposition is hardly probable, as the phrase *huo ts'i* is good old Chinese, and yields a reasonable sense. It occurs in the ancient Book of Rites (*Li ki*, chap. *Yüe-ling*, ed. COUVREUR, Vol. I, p. 401; LEGGE's translation, Vol. I, p. 303): "In the second month of winter, orders were given to the grand superintendent of the preparation of liquors to see that the rice and other glutinous grains be all complete, etc., that the water be fragrant, that the vessels of pottery be good, and that the regulation of the fire (*huo ts'i* 火齊) be right." The term *huo ts'i chu*, accordingly, is very well fitted to signify "a pearl (or gem) used in regulating fire." Indeed, the term *huo-ts'i*, as shown farther on, has been employed for a mineral indigenous in China, and belonging to the mica group, prior to her contact with India; we hear, for instance, of screens (*Shi i ki*, Ch. 5, p. 6; ed. of *Han Wei ts'ung shu*), couches, and finger-rings of *huo-ts'i*, of native manufacture (*ibid.*, Ch. 8, p. 3). This subject is not pursued here any further, as it will be treated by the writer in a special monograph on mica.

in the Annals of China is embodied in the History of the Liang Dynasty,¹ which enumerates it among the products of Central India, and describes it as follows: "*Huo-ts'i*, in its appearance, is like the mica of China,² with a tinge like that of purple gold, and of intense brilliancy. Pieces split off from it are as thin as the cicada's wings; when joined together again, they are like doubled silk gauze."³ This text, however, is not peculiar to the two Annals, but is

¹ *Liang shu*, Ch. 54, p. 7^b. The Liang dynasty covers the period from 502 to 556. Its history was compiled by Yao Se-lien in the first half of the seventh century. The same text is found also in *Nan shi* (Ch. 78, p. 7). The latter work, comprising the history of China from 420 to 589, was elaborated by Li Yen-shou in the seventh century.

² In Chinese *yün-mu* 雲母 (literally, "cloud-mother"). On the basis of a specimen obtained from China, *yün-mu* was identified with mica by E. BIOT (in PAUTHIER-BAZIN, *Chine moderne*, Vol. II, p. 558), who also rejected Rémusat's interpretation of this term as "mother-o'-pearl" (this meaning is erroneously given by PALLADIUS, *Chinese-Russian Dictionary*, Vol. II, p. 543). He pointed out seven varieties bearing different names. Under the same name, *yün-mu*, the different varieties of mica have well been described by GEERTS (*Produits de la nature japonaise et chinoise*, Vol. II, pp. 426—433); while F. PORTER SMITH (*Contributions toward the Materia Medica of China*, p. 210) mistook *yün-mu* for talc, though describing mica under that title. G. SCHLEGEL (*T'oung Pao*, Vol. VI, 1895, p. 49) has contributed to the subject a few notes which are rather inexact; only his erroneous view that *yün-mu* is a modern term, may here be pointed out. As in many studies of orientalists we meet the phraseology "mica or talc," it cannot be strongly enough emphasized that mica and talc are fundamentally different minerals; and it is even difficult to see how they could ever be confounded. The word *yün-mu* has been adopted for the designation of mica in the modern scientific mineralogy of China and Japan (see, for instance, *Journ. Geol. Soc. of Tokyo*, Vol. XIX, 1912, p. 413), while talc is *hua shi* 滑石 or *fei-tsao shi* 肥皂石; the identification of *yün-mu*, therefore, is absolutely certain. The Chinese name arose in consequence of the belief that this mineral forms the basis in the origin of the clouds; that is, strictly speaking, the clouded appearance of the mineral was instrumental in inspiring this popular belief. The Sanskrit designation for mica is *abhra*, a word appearing as early as the fifth century in the Bower Manuscript (A. F. R. HOERNLE, *The Bower Manuscript*, pp. 11, 117). This word means literally "cloud, atmosphere," and thus presents a curious counterpart of the Chinese designation for the same mineral, *yün-mu* ("cloud-mother"). The Chinese alchemists took powdered mica internally in order to insure long life; and when placed in the grave, it was believed to have the effect of preserving the body from decay.

³ 火齊狀如雲母。色如紫金。有光耀。別之則薄如蟬翼。積之則如紗縠之重沓也。

encountered as early as the third century in the *Nan chou i wu chi* 南州異物志 ("Account of Remarkable Objects in the Southern Provinces"), by Wan Chên 萬震,¹ where it is prefaced by the statement that *huo-ts'i* comes from, or is produced in, the country of India;² and it is this work which has doubtless served as a source to the annalist. The brief description of the mineral is perspicuous enough to enable one to recognize in it mica, — a group of minerals that crystallize in the monoclinic system, and consist essentially of aluminum silicate. The striking characteristic of all species is a highly perfect basal cleavage, by which the crystals may be split into the thinnest films (that is, the cicada wings of the Chinese). It is to this property, and to the highly elastic nature of the lamellæ (by which mica is distinguished from the flexible, foliated, but inelastic mineral, talc), as well as to the fact that it is able to withstand high temperatures and is a bad conductor of electricity, that mica owes its commercial value.³

It was not in India, however, that the Chinese acquainted themselves with mica for the first time. Mica is indigenous in many places of China; and a contemporary of Wan Chên, Chang Pu 張勃, the author of a geographical description of the kingdom of Wu,⁴ mentions the mineral "*huo-ts'i*, which is like *yün-mu*, as occurring

¹ According to *Sui shu* (Ch. 33, p. 10), Wan Chên lived in the time of the Wu dynasty (third century).

² 火齊出天竺國 (*T'ai p'ing yü lan*, Ch. 809, p. 2). The only variant encountered in this text is in the fourth sentence: 節如蟬翼 別之 etc., as above. The *Pén ts'ao kang mu* (Ch. 8, p. 18), in the notice of *liu-li*, quotes the same text from the work *I wu chi*, which says that the stone is a product of all countries of southern India.

³ Compare the excellent article "Mica" in G. WATT's *Dictionary of Economic Products of India*, Vol. v, pp. 509—513 (also as separate reprint), where its uses, geological and geographical distribution, as well as mining and trade in India, are fully discussed.

⁴ *Wu lu ti li chi* 吳錄地理志 (see BRETSCHNEIDER, *Bot. Sin.*, pt. 1, No. 1043).

in the district Si-küan.¹ It is composed of many layers, and can accordingly be split. It is of yellow color, resembling gold.”² This, again, is an unmistakable characterization of mica, and of that variety known to us as golden mica (*or de chat*).³ We note that a kind of mica was known in China under the name *huo-ts'i*, and that the Chinese merely rediscovered this particular species in India; the term *huo-ts'i*, therefore, cannot be the rendering of a Sanskrit word, and such a Sanskrit name as might come into question, indeed, does not exist.

Huo-ts'i are referred by the Chinese also to some countries located in south-eastern Asia. In the year 519, Jayavarman, King of Fu-nan (Cambodja), sent an embassy to China, and offered pearls of that description, saffron (*yü-kin*), storax, and other aromatics.⁴ In 528 and 535 two embassies arrived in China from a country called Tan-tan 丹丹, and *huo-ts'i* pearls or beads were included among the tribute-gifts of the latter mission.⁵ Very little is known about this country, and its identification is not ascertained. At the time of the T'ang dynasty (618—906) it is mentioned again as being situated south-east of the island of Hai-nan, and west of the

¹ As the kingdom of Wu comprised the present territory of Kiang-su, Chê-kiang, and parts of An-hui, this locality must have been within the boundaries of these provinces.

² 西倦縣有火齊如雲母。重沓可開。黃似金 (*T'ai p'ing yü lan*, Ch. 809, p. 2). The coincidence of the terms used in this text and the *Nan chou i wu chi* is notable.

³ Now termed in Chinese *kin sing shi* 金星石 (“gold star stone”) or *kin tsing shi* 金精石. See GEERTS, *Produits de la nature japonaise et chinoise*, Vol. II, p. 430; D. HANBURY, *Science Papers*, p. 219; and F. PORTER SMITH, *Contributions toward the Materia Medica of China*, p. 148, who mentions Kiang-nan as a locality where it occurs; this is probably identical with that mentioned in the above Chinese work. The Imperial Geography (*Ta Ts'ing i t'ung chi*, Ch. 244, p. 11) mentions the district of Tê-hua (forming the prefectural city of Kiu-kiang, province of Kiang-si) as producing mica (*yün mu*).

⁴ *Liang shu*, Ch. 54, p. 5^b; or *Nan shi*, Ch. 78, p. 4 (compare PELLIOT, *Bull. de l'Ecole française*, Vol. III, p. 270).

⁵ *Liang shu*, *ibid.*

country To-lo-mo 多羅磨, which is otherwise unknown to us.¹ G. SCHLEGEL,² in a discussion of this passage of the Liang history, without adducing any evidence, rendered the term *huo-ts'i* by "Labrador feldspat," which is an arbitrary and unwarranted opinion.³ Both Fu-nan and Tan-tan, this much is certain, were countries in the sphere of influence of Indian civilization; and in the same manner as Fu-nan received diamonds in consequence of its lively intercourse with India,⁴ so also its *huo-ts'i* gems were undoubtedly derived from the same source.

Aside from India, Fu-nan, and Tan-tan, *huo-ts'i* are listed in the Chinese Annals also among the products of Persia; that is, Persia in the epoch of the Sassanian dynasty.⁵ Since Persia was then in close relations with India, it is highly probable that the *huo-ts'i* of Persia, like many other products attributed to the country by the Chinese,⁶ also hailed from India. We shall revert once again to Persia when discussing the term *mei-hui*.

There is not a single ancient Chinese account that speaks of the use of burning-lenses in regard to *huo-ts'i*.⁷ The only purpose to

¹ *T'ang shu*, Ch. 222 B, p. 4 (compare PELLiot, *Bull. de l'Ecole française*, Vol. IV, p. 284).

² *T'oung Pao*, Vol. X, 1899, p. 460.

³ Schlegel's view that the country Tan-tan should be sought for on the Malay Peninsula, and be identified with the mysterious Dondin, placed by Odoric of Pordenone of the fourteenth century between Ceylon and China, has been refuted by PELLiot (*l. c.*).

⁴ India traded diamonds with Ta Ts'in, Fu-nan, and Kiao-chi (*T'ang shu*, Ch. 221 A, p. 10^b).

⁵ *Pei shi*, Ch. 97, p. 7^b; *Wei shu*, Ch. 102, p. 5^b; *Sui shu*, Ch. 83, p. 7^b.

⁶ HIRTH and ROCKHILL, *Chau Ju-kua*, p. 16.

⁷ The conclusion of some Chinese authors that *huo-ts'i* are burning-lenses may have been prompted partially by the report of a mica mirror (*huo ts'i king*) contained in the *Shi i ki* (Ch. 3, p. 6^b; ed. of *Han Wei ts'ung shu*). This mirror, three feet in width, is alleged to have been sent as a gift by a country styled K'ü-sü 渠胥, at the time of the Emperor Ling of the Chou dynasty (571—545 B.C.). In a dark room, objects were visible in it as in the daytime; and when words were spoken in the direction of the mirror, an echo sounded from it as answer. HIRTH (*Boas Anniversary Volume*, p. 228) sees in this mirror a practical demonstration of the theory of sound-reflection, coupled

which the latter was turned was for making lanterns transparent and durable. This confirms the fact that *huo-ts'i* is mica, for the earliest application of it in India and China was in windows and lanterns.¹ Muscovite, a variety of mica, is still employed for lamp-chimneys, as fire-screens in the peep-holes of furnaces, and as screens in the laboratory, for observing the processes in a highly heated furnace without suffering from the intense heat. It is thus clear why the Chinese called this mineral *huo-ts'i* "fire-regulating;" and it is also clear that, since mica cannot by any means be made into a burning-lens, the alleged identity of *huo-ts'i* with the burning-lens styled *huo-chu* is absolutely wrong. Only the fact that the word "fire" forms the first element in the names of both minerals suggested this hypothesis to the Chinese philologists. But there is a fundamental difference in characterizing the two by the attribute "fire." In mica it refers to that phenomenon known to us as asterism, — the exhibition of a starlike reflection, which occurs also in sapphire, chiefly displayed by some phlogopites when a candle-flame is viewed through a sheet of the mineral, — and the frequent use of the substance for windows, as remarked by Watt, may have facilitated the observation of this peculiar property. The fact that the Chinese were perfectly aware of it has already been demonstrated by the reference to the mica windows in the palaces of Lo-yang; and there is another similar report in the Records of Kuang-tung Province,² according to which the mica of

with that of light-reflection. The text itself, like the book from which it is taken, is apocryphal. The assigning of it to the Emperor Ling is a gross anachronism, and nothing is known about the country K'ü-sü.

¹ Windows of mica are mentioned in a *Description of the Palaces of Lo-yang* (*Lo-yang kung tien ki* 洛陽宮殿記; *T'ai p'ing yü lan*, Ch. 808). They spread a dazzling brilliancy in the sunlight. Also fans were made from the same substance by Shi Hu 石虎 (mentioned in his work *Ye chung ki* 鄴中記; see BRETSCHNEIDER, *Bot. Sin.*, pt. 1, No. 1079).

² *Kuang chou ki* 廣州記, by P'ei Yüan 裴淵, who lived under the Tsin dynasty (265—419); see BRETSCHNEIDER, *Bot. Sin.*, pt. 1, No. 377.

the district of Tsêng-ch'êng, when struck by the sunlight, emits a brilliant light.¹

LIU-LI AND LANG-KAN NOT BURNING-LENSES. — We find also the opinion heralded by Li Shi-chên that the stone *liu-li* 琉璃 (Sanskrit *vaidūrya*) is identical with the *huo-ts'i* gem. This notion goes back to Ch'ên Ts'ang-k'i 陳藏器, who lived during the first part of the eighth century at San-yüan (in the prefecture of Singan, Shen-si Province), and who is the author of the *Pen ts'ao shi i* 本草拾遺. This work seems to be lost; but extracts of it are preserved in the later works on natural history, notably in the *Chéng lei pén ts'ao* 證類本草 of the year 1108, and in the *Pén ts'ao kang mu*. In both works he is quoted as saying that, according to the dictionary *Tsi yün* 集韻, *liu-li* is the same as the gem *huo-ts'i*. This work, of course, is not the *Tsi yün* which was begun in 1034 and completed in 1039,² but the *Tsi yün* or *Yün tsi* by Lü Tsing 呂靜 of the Tsin dynasty (265—419).³ We are here confronted with a purely philological opinion of a lexicographer, which is hardly founded on a personal examination of the objects concerned,⁴ nor is it very likely that Sanskrit *vaidūrya* ever referred to a variety of mica.

¹ 增城縣有雲母向日炤之光耀 (*T'ai p'ing yü lan*, Ch. 808). — The introduction of plate-glass has now supplanted the use of mica in Eastern Asia; but some curious survivals of it still occur in Tibet. The Tibetans manufacture an abundance of charm-boxes (*gau*), some of large dimensions in the form of shrines; a window is cut out in the metal surface to render the image in the interior visible. This window is now usually covered with European glass, but also with a transparent sheet of mica. Ornaments of mica are still employed by the women in the territory of the Kuku-nör for the decoration of their fantastic head-dresses.

² WATERS, *Essays on the Chinese Language*, p. 60.

³ See the Catalogue of Sui Literature (*Sui shu*, Ch. 32, p. 22; and WATERS, *l. c.*, p. 40). *T'ai p'ing yü lan* (Ch. 809, p. 2) quotes the same definition from the dictionary *Yün tsa* 韻雜, which presumably is a misprint for *Yün tsi* 韻集.

⁴ This discussion bears out the reasons which induced F. PORTER SMITH (*Contributions toward the Materia Medica of China*, p. 120) to identify *huo-ts'i* with lapis lazuli, as he took *liu-li* for the latter and encountered the equation of *huo-ts'i* with *liu-li*.

As the term *liu-li* refers to certain varieties of rock-crystal¹ and to certain vitreous products, it would be possible in theory that burning-lenses were made from this substance; but no such instance is on record. There is, however, an isolated case in which a specular lens of this material is in question.

In the year 499, the Buddhist monk Huei Shên 慧深 returned to China under the pretence that he had visited a marvellous island in the farthest east, called Fu-sang 扶桑, and made a glowing report of its wonders. It is well known that a number of European and American scholars sought this alleged country Fu-sang in Mexico or somewhere else in America, and pretended that this continent had been discovered by the Chinese nine centuries before Columbus. Others, of a more sober trend of mind, localized Fu-sang on Sachalin or on islands near Japan. But even this moderate attitude rests on a cardinal error, for Fu-sang, as described by Huei Shên, is not a real country at all, but a product of imagination, a geographical myth, composed of heterogeneous elements, as will be shown by me elsewhere. In this connection Fu-sang is of interest to us, as the earliest Chinese mention of a specular lens is associated with it. In the beginning of the sixth century envoys of Fu-sang are alleged to have appeared in China, "offering as tribute a precious stone for the observation of the sun (*kuan jì yū* 觀日玉), of the size of a mirror, measuring over a foot in circumference, as transparent as rock-crystal (*liu-li*); looking through it in bright sunlight, the palace-buildings could be very clearly distinguished."² The event

¹ It would be preferable to use the general term "quartz," as it is impossible to determine in each and every case what kind of crystal is intended.

² 扶桑國使使貢觀日玉。大如鏡。方圓尺餘。明澈如琉璃。映日以觀日 (variant: 見) 中宮殿皎然分明 (*T'ai p'ing yü lan*, Ch. 805, p. 10). This text is derived from the book *Liang se kung tse ki*, 梁四公子記, "Memoirs of the Four Lords of the Liang Dynasty

of the embassy here alluded to is apocryphal, for it is not on record in the official Annals of the Liang Dynasty; the country Fu-sang itself is an imaginary construction. Moreover, the work which contains this story, and which consists of conversations held by the four Lords¹ with the Emperor Wu of the Liang dynasty (502—549) has a decided tendency toward the wondrous, and teems with fables derived from the West. Notwithstanding, all this does not detract from the value of this first account of a specular lens, through which objects could plainly be beheld. I think that SCHLEGEL² was not so very wrong in lending expression to the opinion that this "precious stone for the observation of the sun" was a rock-crystal.

In his book (happily now forgotten) *Fusang or the Discovery of America by Chinese Buddhist Priests in the Fifth Century* (1875) CH. G. LELAND has utilized also this notice in support of his Fusang-American hypothesis, and has tried to establish an analogy between the observation glass of the Chinese account and the burning-mirrors of metal which the ancient Peruvians are alleged to have employed for kindling their sacred fire. BRETSCHNEIDER³ who banished the nightmare of Leland with as much critical acumen and as a solid fund of information refuted this particular point only by discounting the credibility of the Chinese source in question.⁴

(502—556)," written by Chang Yüe 張說 (667—730), statesman, poet, and painter (GILES, *Biographical Dictionary*, p. 51).

¹ They were Huei-ch'uang 晁闢, Wan-kie 韋免杰, Wei-t'uan 魏黃端, and Chang-ki 仇啓.

² *T'oung Pao*, Vol. III, 1892, p. 139.

³ *Über das Land Fu Sang* (*Mitt. d. Ges. Ostasiens*, Vol. II, No. 11, 1876, pp. 1—11).

⁴ He erroneously styled the work "the memoirs of a certain Liang sze kung." In his *Botanicon Sinicum* (pt. 1, p. 169) the title is correctly explained. In an old catalogue of books from the twelfth century, Bretschneider comments, this work is described as totally unreliable, as the author narrates mostly wondrous and incredible stories. This is merely a conventional Chinese mode of literary criticism. The wondrous stories of this book are of incalculable historical value to us, as many of them are exact reproductions of western legends.

This point of view is unnecessary. We certainly do not have to believe in the embassy from Fu-sang, which is not confirmed by the Annals; the instrument, however, described in the report cannot be a personal invention of Chang Yüe, the author of that work, but surely is a reality. It doubtless was a lens which permitted to see the distant palace-buildings with greater distinction; yet it was not a burning-lens, and the comparison drawn by Leland is far from the point. Moreover, the alleged burning-mirrors of the Peruvians existed merely in the imagination of Garcilaso de la Vega, whose fantasy has already been exploded by E. B. TYLOR.¹

It is possible to trace with some degree of probability the real origin of that lens fancifully associated with the mythical land Fu-sang. The work *Liang se kung tse ki* that contains this account offers the following interesting text: "A large junk of Fu-nan which had hailed from western India arrived (in China) and offered for sale a mirror of a peculiar variety of rock-crystal (碧玻璆鏡),²

¹ *Researches into the Early History of Mankind*, pp. 250—253 (New York, 1878).

² G. PAUTHIER (*L'inscription de Si-ngan-fou*, p. 31, Paris, 1858), who first called attention to this text, was quite correct in explaining the term *p'o-li* as "rock-crystal." PELLLOT (*Bull. de l'Ecole française*, Vol. III, p. 283) accepts *p'o-li* in this passage in the sense, commonly adopted, of "glass," while admitting that it etymologically corresponds to Sanskrit *sphatika*. The latter, however, means "rock-crystal;" and in my opinion the Chinese word *p'o-li*, derived from it, in the greater number of ancient texts, has the same significance. Evidence based on other texts will be produced farther below; here we discuss only the text under consideration. For two weighty reasons it is impossible to regard the mirror mentioned in the *Liang se kung tse ki* as a glass mirror. First,—the story of the merchants, which is an echo of the Western legend of the Diamond Valley, reveals the fact that the question is of a precious stone, not of glass; among the numerous versions of this legend, there is not one that speaks of glass, but all of them are unanimous in mentioning hyacinths, diamonds, or precious stones in general. A plain glass mirror, most assuredly, would not have been priced so highly, nor have caused such a sensation, nor have been linked with a legend of that character. Second,—glass mirrors were not yet invented at that time in the West, and for this reason the conclusion that they should have been known in India and Fu-nan during the sixth century seems to me very hazarded. True it is that HIRTH (*Chinese Metallic Mirrors*, *Boas Ann. Vol.*, p. 219), who also regards this mirror from Fu-nan as being of "green glass" (see, however, also the following footnote), and who wonders at the incredible price solicited for it, supports his theory by

one foot and four inches across its surface, and forty catties in weight. It was pure white and transparent on the surface and in the interior, and displayed many-colored things on its obverse. When held against the light and examined, its substance was not discernible.¹ On in-

the statement that the ancients were acquainted with glass mirrors. This argument, however, is not valid; we have to study only the famous and ingenious treatise of J. BECKMANN (*Beiträge zur Geschichte der Erfindungen*, Vol. III, particularly pp. 302—335; an English translation of this monumental work was published in 1814 by W. JOHNSTON) to become thoroughly convinced of the baselessness of Hirth's claim; and the result of Beckmann, who wrote in 1792, is upheld both by classical philology (MORGAN, *Harvard Studies in Classical Philology*, Vol. I, 1890, pp. 50—51) and by the modern history of technology (FELDHAUS, *Technik der Vorzeit*, col. 1044). The plain fact remains that real glass mirrors in our sense did not come up in Europe before the latter part of the thirteenth century, and that they did not exist in classical antiquity. — I do not deny, of course, that in a later period the term *p'o-li* assumed the meaning of "glass;" the exact date remains to be ascertained.

¹ HIRTH and ROCKHILL (*Chau Ju-kua*, p. 228), who have translated merely the beginning of this text on the basis of an incomplete quotation in *T'u shu tsi ch'eng*, render this sentence, "Objects of all kinds placed before them [the mirrors] are reflected to the sight without one's seeing the mirror itself." Even if this translation were admissible, which I venture to doubt, I am at a loss to understand what it should mean; it even seems to convey the meaning of something that is impossible. The sentence 置五色物於其前 (see the complete text of the passage on p. 202, note 3) cannot be linked with the following 向 etc., which is a new sentence expressing a new idea. This may be inferred also from the text, as quoted in *P'en ts'ao kang mu*, in which the sentence beginning with 置 etc. is omitted, while the sentence beginning with 向 etc. is completely reproduced. Objects are certainly not placed in front of a mirror to be seen, but man wants to behold himself or objects in a mirror. It is obvious that the objects here mentioned were natural designs formed by zones of various colors in the stone. As they were not acquainted with the complete text, as handed down in *T'ai p'ing yü lan*, Hirth and Rockhill understand that the junks of Fu-nan habitually sell such mirrors to the Chinese. Our story renders it clear that only an isolated instance comes into question, and that this particular, unusual mirror could not even be disposed of in China. The *Liang se kung tse ki* is not a work on commercial geography summarizing general data, but is a story-book narrating specific events. We have in the present case not a description, but a narrative. For the rest, however, the notes contributed by Hirth and Rockhill on the history of glass are very interesting and valuable, though many problems connected with this difficult subject still remain unsolved. Hirth's opinion, that *pi-p'o-li* should be regarded as a word-formation prompted by analogy with *pi-liu-li*, is very plausible. Our text indeed renders this conception almost necessary, as the word *pi* cannot be taken here in the sense of "green," the substance of the mirror being described as white and transparent.

quiry for the price, it was given at a million strings of copper coins. The Emperor ordered the officials to raise this sum, but the treasury did not hold enough. Those traders said, 'This mirror is due to the action of the Devarāja of the Rūpadhātu.¹ On felicitous and joyful occasions, he causes the trees of the gods² to pour down a shower of precious stones, and the mountains receive them. The mountains conceal and seize the stones, so that they are difficult to obtain. The flesh of big beasts is cast into the mountains; and when the flesh in these hiding-places becomes so putrefied that it phosphoresces, it resembles a precious stone. Birds carry it off in their beaks, and this is the jewel from which this mirror is made.' Nobody in the empire understood this and dared pay that price."³

The story connected in this report with the crystal mirror is a somewhat abrupt and incomplete version of the well-known legend of the Diamond Valley, the oldest hitherto accessible Western version

¹ 色界天王 ("the Celestial King of the Region of Forms"). The Rūpadhātu is the second of the three Brahmanic worlds. The detailed discussion of this subject on the part of O. FRANKE (*Chinesische Tempelinschrift*, pp. 47—50) is especially worth reading. The Devarāja here in question is Kubera or Vaiçravaṇa, God of Wealth, guarding the northern side of the world-mountain Sumeru and commanding the host of the aerial demons, the Yaksha.

² 天樹. This term corresponds to Sanskrit *devataru*, a designation for the five miraculous trees to be found in Indra's Heaven (compare HOPKINS, *Journ. Am. Or. Soc.*, Vol. xxx, 1910, pp. 352, 353).

³ 梁四公記。扶南大舶從西天竺國來賣碧玻璃鏡面廣一尺四寸重四十斤。內外皎潔置五色物於其前。向明視之不見其質。問其價豹錢百萬貫文。帝令有司算之以府庫當之不足。其商人言。此色界天王。有福樂事天樹大雨雨衆寶山納之。山藏取之難得。以大獸肉投之。藏中肉爛類寶一。鳥銜出而此寶焉。舉國不識無敢酬其價者 (*T'ai p'ing yü lan*, Ch. 808, p. 6).—The narrative is obscure in omitting to state that the jewels adhere to the flesh which is devoured by the birds.

of which is contained in the writings of EPIPHANIUS, Bishop of Constantia in Cyprus (*circa* 315—403).¹ Again, it is the author of that curious work, *Liang se kung tse ki*, who has preserved to us the earliest Chinese form of this legend which strikingly agrees with the story of Epiphanius. This text is worded as follows: "In the period T'ien-kien (502—520) of the Liang dynasty, Prince Kie of Shu (Sze-ch'uan) paid a visit to the Emperor Wu,² and, in the course of conversations which he held with the Emperor's scholars on distant lands, told this story: 'In the west, arriving at the Mediterranean,³ there is in the sea an island of two hundred square miles (*li*). On this island is a large forest abounding in trees with precious stones, and inhabited by over ten thousand families. These men show great ability in cleverly working gems,⁴ which are named for the country Fu-lin 拂林.⁵ In a northwesterly direction from

¹ *Epiphani's opera*, ed. DINDORF, Vol. iv, p. 190 (Leipzig, 1862). On the basis of these new Chinese sources, I have treated the history of this legend in detail in a study on the diamond (unpublished manuscript of the writer), and therefore do not pursue the subject further on this occasion.

² He was the first emperor of the Liang dynasty and lived from 464 to 549 (GILES, *Biographical Dictionary*, p. 285).

³ *Si hai* 西海 (the "Western Sea"). Compare HIRTH, *Journ. Am. Or. Soc.*, Vol. XXXIII, 1913, p. 195.

⁴ This must be referred to the cutting and engraving of antique intaglios (gems in the sense of Latin *gemma*).

⁵ The same mode of writing (林 instead of the later 森) as that encountered by CHAVANNES (*T'oung Pao*, 1904, p. 38) in a text of 607, extracted from the *Ts'ê fu yüan kuei*. The same way of writing occurs also in *Yu yang tsa tsu* and in a poem of the T'ang Emperor T'ai-tsung (*P'ei wên yün fu*, Ch. 27, p. 25). As our text speaks of a forest of jewelled trees, a popular interpretation of the name Fu-lin apparently is intended here, "forest" (林) of the jewels being read into Fu-lin; as if it were "forest of Fu." We are here confronted with the earliest allusion in Chinese records to the country Fu-lin, antedating our previous knowledge of it by a century, Hirth having traced the first appearance of the name to the first half of the seventh century. The reference to the period T'ien-kien (502—520), and the mention of the Liang Emperor Wu, are exact chronological indications which now carry Chinese acquaintance with Fu-lin to the beginning of the sixth century. This result perfectly harmonizes with the view expressed by PELLiot (*Journal asiatique*, Mars-Avril, 1914, p. 498), that the name Fu-lin appears with certainty about 550, and that it is possibly still older.

the island is a ravine hollowed out like a bowl, more than a thousand feet deep. They throw flesh into this valley. Birds take it up in their beaks, whereupon they drop the precious stones. The biggest of these have a weight of five catties.' There is a saying that this is the treasury of the Devarāja of the Rūpadhātu."¹ This is not the occasion to discuss the history and development of this interesting legend in connection with its Arabic and subsequent Chinese parallels; this will be done by me in another place. Suffice it to say for the present that the Chinese version is an exact parallel to that of Epiphanius, that it antedates all Arabic versions, that it represents a purer form than the earliest Arabic text in the *lapidarium* of Pseudo-Aristotle, and that it was transmitted to China directly from Fu-lin. I have here fallen back on these two texts of the *Liang se kung tse ki* to introduce the reader to the mental horizon of its author, Chang Yüé, and thus to secure a basis for judging the *raison d'être* of the specular lens ascribed by him to an embassy from Fu-sang. It was a plausible *a priori* supposition that this instrument must have been one of Western manufacture; and being now familiar with the outfits and tools of the workshop of Chang Yüé, who absorbed traditions of Fu-nan, India, and Fu-lin, we may well infer that the alleged Fu-sang lens was really a

梁四公記。梁天監中有蜀杰公謁武帝嘗與諸儒語及方域。西至西海海中有島方二百里。島上有大林。林皆寶樹中有萬餘家。其人皆巧能造寶器所謂拂林國也。島西北有坑盤坳深千餘尺。以肉投之。鳥銜寶出大者重五斤。彼云是色界天王之寶藏 (T'u shu tsi ch'êng,

section on national economy 321, 寶貨, *tsung pu ki shi*, p. 5). — The last sentence, of course, is not an element inherent in the story, as it came from Fu-lin, but is an interpolation of the Chinese author Chang Yüé, taken from the narrative which the traders of Fu-nan had overheard in India.

product of Syria (Fu-lin) and reached China possibly by way of India and Cambodja (Fu-nan), in the same manner as the costly mirror of rock-crystal.¹

A product termed *lang-kan* 琅玕 is identified with *huo-ts'i* by Su Kung 蘇恭 of the T'ang period,² who, at the same time defines the former as a kind of *liu-li*. K'ou Tsung-shi 寇宗奭, in his *Pên ts'ao yen i* 本草衍義 of 1116, calls him to task for this wrong statement by observing that *liu-li* is a substance evolved by fire, while *lang-kan* is not, so that the two could not represent identical species. Su Kung's identification has indeed not been adopted by any subsequent Chinese scholar.³

¹ In the writer's proposed Chinese-Hellenistic studies will be found several interesting examples of Hellenistic folk-lore traditions looming up in Fu-nan and thence transmitted to China.

² *Chéng lei pên ts'ao*, Ch. 5, fol. 26. Also in a commentary to the dictionary *Ki tsiu pien* 急就篇 (*P'ei wén yün fu*, Ch. 7 A, p. 106 b).

³ *Lang-kan*, in times of antiquity, appears as a mineral, mentioned already in the earliest Chinese document, the tribute of Yü, in the *Shu king* (LEGGE, *Chinese Classics*, Vol. III, p. 127), as a product of the province of Yung-chou; its exact nature cannot be determined, the commentators saying no more than that it was a stone used for beads; Legge's explanation that possibly it was lazulite or lapis lazuli, is purely conjectural. The *Shuo wén* defines *lang-kan* as a stone resembling jade; and the *Erh ya* localizes it in the K'un-lun. The *Pie lu* 別錄 assigns the stone to P'ing-tsê 平澤 in Shu 蜀 (Sze-ch'uan). *Wei lio*, *Hou Han shu*, *Liang shu*, and *Wei shu* (HIRTH, *China and the Roman Orient*, pp. 41, 47, 50, 73) mention *lang-kan* among the products of Ta Ts'in; no explanation of its significance with reference to these passages is on record. We find *lang-kan* also in Kucha (*Liang shu*, Ch. 54, p. 14), in central India (*ibid.*, p. 7 b), and generally in India (*T'ang shu*, Ch. 221 A, p. 10 b). From the T'ang period onward the Chinese naturalists or pharamacists, beginning with Ch'ên Ts'ang-k'i, describe *lang-kan* as a kind of coral, growing like a tree with root and branches on the bottom of the sea, fished by means of nets, and being reddish, when coming out of the water, but subsequently turning darker. The *Yün lin shi p'u* (Ch. c, p. 9 b) says that it is a stone caught in shallow places near the coast of Ning-po, resembling the genuine coral (*shan-hu*), being white, when coming out of the water, and afterwards turning purple or black. Li Shi-chên objects to the application of the term *lang-kan* to these marine products which, according to him, should be credited with the name *shan-hu*, while the former should be restricted to a stone occurring in the mountains. Compare also SCHLEGEL, *T'oung Pao*, Vol. VI, 1895, p. 58; F. DE MÉLY, *Lapidaires chinois*, p. 56; HIRTH and ROCKHILL, *Chau Ju-kua*, pp. 162, 226. The word *lang-kan* seems to be an onomatopoeic formation descriptive of the

THE MINERALOGICAL TERM MEI-HUI. — Finally we have to discuss the term *mei-hui* 玫瑰, which, according to Li Shi-chên, also should refer to lenses. It first appears in the poem *Tse hiü fu* 子虛賦 of Se-ma Siang ju, who died in 117 B.C., as one of the mineral products of Sze-ch'uan.¹ Kuo P'o (275–324) explains it as a stone bead 石珠; Tsin Pao 晉灼 says that it is identical with *huo-ts'i* beads; and Yen Shi-ku (579–645) reiterates the same, adding that "is is the 'fire-pearl' coming at present from the countries of the south."² These definitions are vague and unsatisfactory, being made by philologists who in all probability had never seen any of the stones in question. Yen Shi-ku errs in identifying *huo-ts'i* with *huo-chu*, and therefore the identification of both with *mei-hui* is presumably wrong also. The dictionary *Shuo wên* (A.D. 123) notes *huo-ts'i* as an equivalent or synonyme of *mei-hui*; as we have shown that the former covers the group of micas, it would follow from this definition, provided it is correct, that *mei-hui* should be a variety of mica, and consequently cannot be a burning-lens.

The term *mei-hui* is listed also in the ancient vocabulary *Ki tsiu chang* 急就章, edited by Shi Yu 史游 under the reign

sound yielded by the sonorous stone when struck (compare the words *lang* 琅, "rumbling of stones, roll of a drum;" and *lang* 朗, "clear, as light or sound;" *lang-t'ang* 朗鎧 is used in Peking as an interjectional expression, imitative of the noise of gongs and drums; in general compare chap. IV of WATTERS, *Essays on the Chinese Language*). This point of view would account for the fact that the name *lang-kan* was transferred from a stone to a coral; for Tu Wan, in his *Yün lin shi p'u* (l.c.), expressly states that the coral *lang-kan* when struck develops resonant properties.

¹ *Shi ki*, Ch. 117, p. 2 b; and *Ts'ien Han shu*, Ch. 57 A, p. 2 b. Yen Shi-ku defines the pronunciation of the two characters as *mei* and *hui* (or *huei*), but admits for the latter also the sound *kuei* (玫音枚。瑰音回。又音瓊).

² 火齊珠。今南方之出火珠也。 This clause is interesting, inasmuch as it proves the importation of lenses into China in the first half of the seventh century,—a fact which, as will be seen, is confirmed by the T'ang Annals.

of the Emperor Yüan (48–33 B.C.),¹ with reference to jars made from this stone and three others. It is simply defined as “fine jade” in the commentary. This explanation, again, would banish any idea of burning-lenses.²

What the *mei-hui* mentioned by Se-ma Siang-ju was, no Chinese commentators really knew. Their explanations are makeshifts to conceal their lack of proper knowledge of the subject. This much seems certain, that the *mei-hui* of Sze-ch’uan was not mica (*huo-ts’i*), first, because mica is not known to occur there; and, second, because the name *mei-hui* denotes also the rose,³ and accordingly the mineralogical term seems to refer to a rose-colored stone. For this reason it seems out of the question also that it could have been used as a lens, and there is indeed no account to this effect, mentioning the employment of *mei-hui*. The case, therefore, is one of purely literary extension of significance. The original meaning of the word having fallen into oblivion, it

¹ Regarding this work see the important study of CHAVANNES, *Documents chinois découverts par Aurel Stein*, pp. 1–10. The passage referred to is in *Pien tse lei pien*, Ch. 70, p. 13 b.

² The apocryphal work *Shu i ki*, of the sixth century, which has not come down to us in its original form, is credited with the statement, “Snake-pearls are those vomited by a snake. There is a saying in the districts of the Southern Sea (Kuang-tung, etc.) that a thousand snake-pearls are not the equivalent of a single *mei-hui*, which means that snake-pearls are low in price. Also *mei-hui* is the designation of a pearl (or bead, jewel).”

³ *Rosa rugosa*, with red and pink flowers (G. A. STUART, *Chinese Materia Medica*, p. 381; and M. J. SCHLEIDEN, *Die Rose, Geschichte und Symbolik*, p. 228, who enumerates several species of rose in China). The Japanese naturalist Ono Ranzan states that the precious stone *mei-hui* is named for the color of the flowers of *Rosa rugosa*, and invokes the Chinese work *T’ien kung k’ai wu* 天工開物 by Sung Ying-sing of 1628 (2d ed., 1637), as his authority (GEERTS, *Produits de la nature japonaise et chinoise*, Vol. II, p. 360). I cannot trace this reference in the latter work, but find there that *mei-hui* is treated as a special kind of precious stone “resembling yellow or green peas; the biggest are red, green, blue, yellow, in short, occurring in all colors; and there are also *mei-hui* like pearls” (see *T’u shu tsi ch’êng*, chapter on precious stones, *pao shi*). Yet I am convinced that Ono Ranzan encountered this statement in some Chinese book, and may have erred only in quoting the *T’ien kung k’ai wu*.

became free to assume the same meaning as *huo-ts'i*, in the rôle of an elegant term of the *estilo culto*. The fact that it really interchanges with the latter is manifested by the account of Persia in *Nan shi*,¹ where *mei-hui* are listed among the products of that country: while, as mentioned on p. 195, the analogous reports in *Pei shi*, *Wei shu* and *Sui shu* have the term *huo-ts'i* in the same passage. Thus the greatest probability is that also *mei-hui*, as used in this text of the *Nan shi*, denotes the mica of India. As regards other foreign countries, we find *mei-hui* mentioned in the *Wei lio*, written by Yü Huan between 239 and 265, as a product of the Roman Orient ('Ta Ts'in'),² and worn on the high head-dress of the women of the King of the Ephtalites (Ye-ta).³

After having overthrown the nebular hypotheses of foreign and Chinese scholars, the path is finally cleared for discussing the real thing, the history of burning-lenses in China. There is only one term in the Chinese language which may lay claim to having this significance, and that is *huo chu* 火珠 (the "fire-pearl").

INTRODUCTION OF BURNING-LENSES INTO CHINA. — The first historical mention of "fire-pearls" (*huo chu*) is made in the Annals of the T'ang Dynasty (618—906),⁴ where they are connected with a tribe of Malayan or Negrito stock, styled "Lo-ch'a" 羅刹, and inhabiting an island in the Archipelago east of P'o-li 婆利 (Bali). "Their country," it is said, "produces fire-pearls in great number, the biggest reaching the size of a fowl's egg. They are round and white, and emit light at a distance of several feet. When held

¹ Ch. 79, p. 8.

² HIRTH, *China and the Roman Orient*, p. 73.

³ *Lo-yang kia lan ki* 洛陽伽藍記, written in 547 by Yang Hsian-chi 楊街之 (quoted in *T'u shu tsi ch'eng*, *Pien i tien* 67, Ye-ta, *hui k'ao* 2).

⁴ *T'ang shu*, Ch. 222 c, p. 1 b.

against the rays of the sun, mugwort¹ and rushes² will be ignited at once by fire springing from the pearl.”³ The same text, with slightly varying phraseology, is given also in the *Old History of the T'ang Dynasty*,⁴ where, however, the interesting addition occurs, that this pearl is in appearance like crystal (狀如水晶). Hence we may justly conclude that these fire-pearls were convex crystal lenses, whose optical properties were utilized in producing fire for the medical purpose of cauterization.⁵

¹ Chinese *ai* 艾, *Artemisia vulgaris*, a plant common in China and from ancient times used in cauterizing the skin (see BRETSCHNEIDER, *Bot. Sin.*, pt. 2, No. 429; pt. 3, No. 72),—a process known to us by the Japanese name *moxa* (properly *mogusa*, the Jap. word for *Artemisia*). The best leaves are taken and ground up with water in a stone mortar, the coarsest particles being eliminated, and the remainder being dried. A small portion is rolled into a pellet the size of a pea, placed upon the ulcer or spot to be cauterized. The preferred method of igniting the moxa is still by means of a burning glass or mirror (compare G. A. STUART, *Chinese Materia Medica*, p. 53). The most interesting and detailed account of this practice was written by ENGELBERT KAEMPFER in the seventeenth century (*History of Japan*, Glasgow edition, Vol. III, pp. 277—292). Kaempfer states that the Japanese used burning splinters or incense-sticks to ignite the moxa.

² KAEMPFER (*l. c.*, p. 276) informs us that the most common caustic used by the Brahmans of India is the pith of rushes, which grow in morassy places. This pith they dip into sesamum-seed oil, and burn the skin with it after the common manner.

³ 多火珠。大者如雞卵。圓白照數尺。日中以艾藉珠輒火出。

⁴ *Kiu T'ang shu*, Ch. 197, p. 1 b.

⁵ GROENEVELDT (*Notes on the Malay Archipelago*, p. 206, in *Miscell. papers relating to Indo-China*, Vol. 1), who was the first to indicate the relevant passage of the *T'ang shu* (but neglected the corresponding text of the *Kiu T'ang shu*), was therefore wrong in affirming that the fire-pearl is “evidently a kind of burning-glass, but whether of glass or crystal, and manufactured in what place, we have no means to ascertain.” We have, as will be seen farther on, the means of ascertaining that these crystal lenses were manufactured in India. Another error of Groeneveldt was to assign the fire-pearls to the country of P'o-li instead of Lo-ch'a. PELLIOU (*Bull. de l'Ecole française*, Vol. IV, p. 283, note 3) has clearly pointed out the confusion prevailing in this chapter of the *T'ang Annals*, and has shown that it was the wild men of Lo-ch'a visiting the coasts of Champa in order to sell these crystal lenses, carrying on their trade at night, while hiding their faces during the day (*ibid.*, p. 281, but he too speaks of “lentilles de verre”). G. SCHLEGEL (*T'oung Pao*, Vol. IX, 1898, p. 178; and 1901, p. 334), who revealed the same text from the Chinese Gazetteer of Kuang-tung Province, offered the inadequate translation, “Their country produces car-

The crystal lenses, accordingly, were employed in the same manner as the burning-mirrors of copper or bronze in a former period. The *Ku kin chu* 古今注¹ of Ts'uei Pao 崔豹 of the fourth century states that the latter served for the purpose of setting mugwort on fire.²

The Annals of the Tang Dynasty indicate also the fact that in 630 King Fan-t'ou-li 范頭黎 sent an embassy to China to present such lenses.³ It is this text of the Tang Annals which gave to Li Shi-chên occasion for his general statement of the subject, as quoted above. We now observe that he has cited the text inaccurately, and has credited it with the term *huo-ts'i-chu* instead of *huo chu*. The former, however, as we have seen, denotes mica, which cannot be used for lenses; the latter relates to rock-crystal; and it is essential to discriminate between the two. Likewise it is not to the point when he asserts that the lenses now found in Champa are styled "great fire-pearls of the morning dawn." "Morning dawn" (*chao hia*) is well known to us as the designation of a specific textile fabric;⁴ and in the passage of the Tang Annals indicated it happens that the two terms "morning-dawn cloth" and "fire-pearl" (*chao hia pu huo chu* 朝霞布火珠) are closely joined, hence arose, apparently, the misunderstanding of Li Shi-chên.

buncles (*huo chu*) which are like crystals." Carbuncles certainly are not like crystals, nor can they be utilized as optical lenses. C. PUINI (*Enciclopedia sinico-giapponese*, p. 65, Firenze, 1877) had already indicated that *huo chu* is a species of quartz.

¹ Ch. c, p. 5 b (ed. of *Han Wei Ts'ung shu*).

² 陽燧以銅爲之。形如鏡。何日則火生以艾承之則得火也。

³ The last clause in the definition of these is worded in the *Old History* thus: "When held against the sun at noon in order to ignite mugwort, the latter is consumed by fire" (正午向日以艾蒸之即火燃).

⁴ PELLLOT, *T'oung Pao*, 1912, p. 480; GILES, *Adversaria Sinica*, p. 394; LAUFER, *T'oung Pao*, 1913, pp. 339, 340; *Ling-wai tai ta*, Ch. 6, p. 13.

A book entitled *Sui T'ang kia hua* 隋唐佳話¹ informs us that in the beginning of the period Chêng-kuan (627—650) the country Champa (Lin-yi) offered to the Court burning-lenses (*huo chu*), in appearance like rock-crystal, stating that the people of Champa had obtained them from the Lo-ch'a country, whose inhabitants have red hair, a black skin, teeth like animals, and claws like hawks.²

The Lo-ch'a or Rākshasa, who, judging from the unflattering description of the Chinese, were a wretched, savage tribe (but sufficiently advanced to practise navigation and to trade with Champa),

¹ Quoted in *Pien tse lei pien*, Ch. 21, p. 5 b.

² Chinese *Lo-ch'a* is the transcription of the Sanskrit word *Rākshasa*. The latter is the designation for a class of man-devouring ogres with red neck and eyes, and protruding tusks, roaming about at night and doing mischief to mankind. It was believed by Groeneveldt and Schlegel that the country of the Lo-ch'a mentioned in the T'ang Annals is identical with the Nicobar Islands; but PELLiot (*Bull. de l'Ecole française*, Vol. iv, p. 281) has rightly demonstrated the baselessness of this theory, with the result that the country of the Lo-ch'a in question was situated east of P'o-li, which is identical with Bali, the island east of Java. GERINI (*Researches on Ptolemy's Geography of Eastern Asia*, p. 497) likewise has antagonized that theory, arguing that Lo-ch'a refers to the more southern parts of the Malay Peninsula, and perhaps stands also for the wilder tribes of Negrito-Sakai stock populating its eastern coast; but this opinion conflicts with the Chinese accounts of Lo-ch'a. In the belief of the Indians, the main abode of the Rākshasa demons was Ceylon (Langkā), which for this reason was styled also Rākshasālaya ("Abode of the Rākshasa"); and as such, Ceylon appears in the great epic poem Rāmāyaṇa, in which King Rāma combats these fierce devils of Ceylon. A country of the Rākshasa plays a signal rôle in the Tibetan cycle of legends clustering around Padmasambhava, who lived in the eighth century (see E. SCHLAGINTWEIT, *Lebensbeschreibung von P.*, I, p. 21; and LAUFER, *Roman einer tibetischen Königin*, p. 224). It would be tempting to regard the Lo-ch'a as a tribe like the Vedda of Ceylon, but for geographical reasons it is assuredly impossible to place the Lo-ch'a on Ceylon. Such a nickname as Rākshasa could certainly have been applied by the superior castes of India to any inferior aboriginal tribes (compare the note of YULE, in his *Marco Polo*, Vol. II, p. 312, regarding a Brahman tradition that the Rākshasas had their residence on the Andamans, and the analogous application in India of the words *Nāga* and *Piçāca*). Indian traditions referring to Rākshasa tribes, therefore, cannot assist us toward the identification of the Lo-ch'a country of the T'ang period, which, as justly upheld by Pelliot, was an island in an easterly direction from Bali. It may be supposed that it was the highly cultivated peoples of Java and Bali who conferred the name "Rākshasa" on that primitive tribe in their proximity.

certainly were themselves not able to produce fire-making lenses.¹ From what quarters was their supply derived? We are informed by the Annals of the T'ang Dynasty that in the year 641 Magadha in India sent to the Chinese Court tribute-gifts among which appeared fire-lenses (*huo chu*),² and, further, that Kashmir produces fire-lenses, saffron, and horses of the dragon breed.³ The latter notice is contained also in the memoirs written by the celebrated pilgrim Hsüan Tsang in 646;⁴ and his statement, based on actual observation, was doubtless the source from which the official history of the T'ang dynasty drew. The Arabic mineralogists also — as, for instance, al-Akfānī — knew Kashmir as a country producing rock-crystal.⁵

In the beginning of the period K'ai-yüan (713—742) Kashmir sent as tribute "pearls of supreme purity" (*shang ts'ing chu* 上清珠), illuminating an entire house with their splendor.⁶ Possibly also in this case crystal lenses are understood.

I Tsing, the Buddhist monk and traveller, who journeyed in India from 671 to 695, observes, "It is only in China where stones are internally taken as medicine. Since rock-crystal and marble emit

¹ GERINI (*l. c.*, p. 491), who erroneously locates the Lo-ch'a on the east coast of the southern portion of the Malay Peninsula, conjectures with reference to these crystal lenses that rock-crystal "very likely" occurs in that region. This point of view is quite immaterial. Whether rock-crystal is found there or not, the Lo-ch'a certainly did not quarry it; and if they did, it was not wrought by them into lenses. Quartz, for instance, is common on the Andamans, but the natives make it only into chips or flakes used in shaving or tattooing, while even the art of eliciting fire from the stone by means of striking is wholly unknown to them (E. H. MANN, *Journ. Anthropol. Inst.*, Vol. XII, 1883, p. 381).

² *T'ang shu*, Ch. 221 A, p. 11.

³ *T'ang shu*, Ch. 221 B, p. 6. Compare CHAVANNES, *Documents sur les Tou-kiue occidentaux*, p. 166.

⁴ JULIEN, *Mémoires sur les contrées occidentales*, Vol. I, p. 167, who translates "glass lenses"; and WATTERS, *On Yuan Chwang's Travels in India*, Vol. II, p. 261.

⁵ WIEDEMANN, *Zur Mineralogie im Islam*, p. 206. Al-Akfānī died in 1348.

⁶ *Tu yang tsa pien* by Su Ngo, Ch. A, p. 3 (ed. of *Pai hai*).

sparks of fire, the organs of the body, if those stones are administered, may be scorched and ripped open. Many of our contemporaries, being unaware of this fact, have suffered death in consequence of this wrong treatment."¹ In Chinese alchemy preparations made from jade and mica played a signal part, and were consumed by ambitious devotees to insure long life or immortality.² When crystal lenses made their appearance in China, the belief was naturally fostered that fire was a substance inherent in the stone. Fire was considered as an element belonging to the male, creative, and life-giving principle called *yang*, so that a mineral partaking of it was apt to strengthen the body and to prolong life. The evil effect of the internal application of rock-crystal, as conceived by I Tsing, thus becomes intelligible: in the same manner as a crystal lens can set fire to an object, so it may cause the human body to catch fire.

The information given in the T'ang Annals with regard to the Lo-ch'a originated from the mission which carried Ch'ang Tsiün 常駿 in the year 607 into the country Ch'i-t'u 赤土. On his journey he is said to have reached the country of the Lo-ch'a, while in another passage it is stated that owing to this mission the inhabitants of the Lo-ch'a country entered into relations with China.³

¹ *Nan hai ki kuei nei fa chuan*, Ch. 3, p. 20 (ed. of Tōkyō); compare J. TAKAKUSU (*Record of the Buddhist Religion*, p. 135), who wrongly takes the term *pai shi* 白石 (literally, "white stone") for adular, which does not occur and is unknown in China; *pai shi* repeatedly appears in the votive inscriptions on Buddhist marble sculptures of the T'ang period, and is still the current expression for "marble." It would be possible that I Tsing employed the term *pai shi* as a rendering of Sanskrit *śītopala* ("white stone"), which is a synonyme of *sphaṭika* and accordingly a variety of quartz or rock-crystal (R. GARBE, *Die indischen Mineralien*, p. 87). Takakusu speaks of "the swallowing of a stone;" the stones were of course triturated and powdered, the mass was kneaded and prepared with other ingredients.

² Under the Sui (589—618) was still extant a treatise on the Method of Prescriptions in administering Jade (*Fu yü fang fa* 服玉方法). See *Sui shu*, Ch. 34, p. 21.

³ PELLiot, *Bull. de l'Ecole française*, Vol. IV, p. 281.

The latter statement seems to be the more probable of the two. The date 607 may thus be fixed as the time when the Chinese made their first acquaintance with burning-lenses; and during the first part of the seventh century a somewhat lively trade in the article was carried on from Champa to China. Hence Yen Shi-ku (579—645), as mentioned, justly points to the importation of burning-lenses from the south during his time. While, as a last resort, the Lo-ch'a lenses are traceable to India, we have as yet no means of ascertaining through what channels these lenses were transmitted from India to the Lo-ch'a. At this point there is a lacune in our knowledge which I am unable to fill; it may be supposed only that Sumatra or Java, or both countries, acted as middlemen in this traffic, but I regret having no certain facts along this line to offer.

It is curious that a tribe of such a low degree of culture as the Lo-ch'a possessed burning-lenses, and was instrumental in conveying this Indian article to Champa and China. This fact we may explain from ethnographical conditions of the present time, with which we are familiar: the Lo-ch'a, though acquainted with natural fire and its uses, must have been a tribe that did not know of any practical method of producing fire. Such a people, for example, we meet among the Andamanese, of whom E. H. MAN¹ says, "The Andamanese are unable to produce fire, and there is no tradition pointing to the belief that their ancestors were their superiors in this respect. As they live in the vicinity of two islands, one of which contains an extinct, and the other an active volcano, it seems not unreasonable to assume that their knowledge of fire was first derived from this source. Being strangers to any method of producing a flame, they naturally display much care and skill in the

¹ *Journ. Anthropol. Inst.*, Vol. XI, 1882, p. 272; compare also Vol. XII, 1883, p. 150.

measures they adopt for avoiding such inconvenience as might be caused by the extinction of their fires. Both when encamped and while journeying, the means employed are at once simple and effective. When they all leave an encampment with the intention of returning in a few days, besides taking with them one or more smouldering logs, wrapped in leaves if the weather be wet, they place a large burning log or faggot in some sheltered spot, where, owing to the character and condition of the wood invariably selected on these occasions, it smoulders for several days, and can be easily rekindled when required." Nothing introduced by the English so impressed this people with the extent of their power and resources as matches. It is notable also that the household fire is not held sacred by the Andamanese, or regarded as symbolical of family ties, and that no rites are connected with it; there are not even beliefs with reference to its extinction or pollution. The Lo-ch'a must have lived under exactly the same conditions when burning-lenses were first introduced among them from India. Not familiar with any practical method of fire-making or any fire-ceremonial, they readily took to this easy expedient, as the modern Andamanese did to our matches. It is still the primitive tribes spending most of their time in the open air, like the Lepcha and Tibetans (see below), who evince a predilection for the application of the burning-lens in fire-making.

Besides the name *huo chū* 火珠, the term *huo suì chu* ("fire-igniting lens") is found in the *Chéng lei pén ts'ao*, completed by Tang Shên-wei in 1108.¹ From the same work it follows also

¹ 火燧珠向日取得火 (*Chéng lei pén ts'ao*, Ch. 3, fol. 44, edition of 1523). This is the concluding sentence of a brief notice on *p'o-li* (see above, p. 200). Both the *Chéng lei* and the *Pén ts'ao kang mu* accept this term in the sense of "rock-crystal" (*sphaṭika*), Li Shi-chên giving as synonyme the term *shui yū* 水玉, which appears in the *Shan hai king* and in the poem on the Shang-lin Palace 上林賦

that burning-lenses were manufactured in China under the Sung. Whether this was the case under the T'ang I am unable to say.

BURNING-LENSES IN INDIA AND SIAM. — The preceding Chinese accounts are clear enough to allow the inference that the so-called "fire-pearls" were lenses of rock-crystal cut into convex shape, that they were used for cauterization in the same manner as reported by Pliny, and that they were introduced into China, through the medium of the Lo-ch'a and of Champa, from Kashmir, or other regions belonging to the culture-zone of India. In short, what the

of Se-ma Siang-ju: its transparency, he says, equals that of water, its hardness that of jade, hence this term; the name "water-jade" is identical with rock-crystal (其瑩如水。其堅如玉。故名。水玉與水精同名). The opinion of both T'ang Shên-wei and Li Shi-chên goes back to Ch'ên Ts'ang-k'î of the T'ang period, whose definition of *p'o-li* is as follows: "*P'o-li* is a precious stone of the Western countries. It belongs to the category of hard stones, and is developed in the soil. According to the opinion of some it results from the transformation of ice that is a thousand years old; but this is certainly not the case" (陳藏器曰。玻瓈西國之寶也。玉石之類。生土中。或云千歲冰所化。亦未必然). Nobody, as far as I know, has as yet explained the statement of Li Shi-chên that the original mode of writing is 頗黎, and that this name *P'o-li* is the designation of a country. *T'ai p'ing yü lan* (Ch. 808, p. 6) quotes a work *T'ien chu ki* 天竺記 ("Memoirs of India") as follows: "In the Himalaya, there is the mountain of precious stones producing the complete series of the seven gems (*saptaratna*), all of which may be obtained. Only the *p'o-li* gem is produced on such lofty peaks that it is difficult to obtain" (大雪山中有寶山諸七寶並生取可得。唯頗黎寶生高峯難得). Here we are confronted with the reproduction of an Indian notion that meets its parallel in the *Ratnaparīkshā*, according to which rock-crystal is a product of Nepal (L. FINOT, *Lapidaires indiens*, p. 56). Certainly the people of India did not hunt for glass on the heights of the Himalaya. The King of Nepal adorned himself with pearls, *p'o-li*, mother-o'-pearl, coral, and amber (*T'ang shu*, Ch. 221 A, p. 1); his *p'o-li* certainly were a kind of rock-crystal, as also S. LÉVI (*Le Népal*, Vol. 1, p. 164) understands, but not glass. The Buddhist monk Hsuei Yüan 慧苑 of the T'ang period, in his Glossary to the *Buddhavataṃsaka-sūtra* (華嚴經音義, Ch. 1, p. 8, ed. of *Shou shan ko ts'ung shu*, Vol. 94; see Bunyiu Nanjio, No. 1606), explains *p'o-li* as "to some degree resembling in appearance rock-crystal (水精; that is, the variety of rock-crystal indigenous in China), yet occurring also in red and white varieties."

Chinese received were Indian manufactures. Hence it is legitimate to conclude that the Chinese name *huo-chu*, conferred upon these lenses, represents the translation of a corresponding Sanskrit term. Such, indeed, exists in the Sanskrit compound *agnimaṇi*, the first element of which (*agni*) means "fire," answering to Chinese *huo*; and the second part of which (*maṇi*) signifies a "pearl, bead, gem, or jewel," exactly like the Chinese word *chu*.¹ Moreover, Sanskrit *agnimaṇi*, according to the Sanskrit Dictionary of Boehtlingk, is an epithet of the stone *sūryakānta*, which means "beloved by the sun," so called because it produces fire under the influence of solar rays. Other synonymes are *tapanamaṇi* ("sun jewel"), *tāpana* ("dedicated to the sun"), *dīptopala* ("refulgent stone"), *agnigarbha* ("essence of fire"), — all of these, as correctly seen by L. FINOT,² referring to rock-crystal. A Hindu treatise on precious stones, the *Navaratnaparikshā*, says, under the subject of rock-crystal, that the

¹ Although apparently formed in imitation of this Sanskrit expression, the term *huo chu*, notwithstanding, pre-existed in China independently of Indian influence, but in a widely different sense. The following story is on record in the Annals of the Tsin Dynasty (*Tsin shu*, Ch. 99, p. 1; biography of Hêng Hūan 桓玄). His mother, née Ma 馬氏, was sitting out one night with her companions in the moonlight, and saw a shooting-star fall into a copper basin filled with water. In the water appeared what looked like a fire-pearl (*huo chu* 火珠) of two inches, diffusing a bright, clear light. Madame Ma took it out with a gourd ladle and swallowed it. When she gave birth to her son, the house was filled with effulgent light; hence the infant received the name Ling-pao 靈寶 (that is, "Supernatural Treasure"). It is evident that this "fire-pearl" was a product of meteoric origin. A similar account is found in the Bamboo Annals: Siu-ki 修己, the mother of the Emperor Yü 禹, saw a falling-star, and in a dream her thoughts were moved till she became pregnant, after which she swallowed a spirit pearl (LEGGE, *Chinese Classics*, Vol. III, Prolegomena, p. 117). The term *huo chu* appears again in *Tsin shu* (Ch. 25, p. 13 b) in connection with the description of the costume, ornaments, and paraphernalia worn by the heir-apparent. There is no explanation of its meaning in this text: perhaps it was a flaming or sparkling gem. In the latter sense I encountered the term in two passages of the *Shi i ki* (Ch. 5, p. 5 b; and Ch. 7, p. 2; ed. of *Han Wei ts'ang shu*); in one case the question is of an extraneous hairpin adorned with a fire-pearl dragon and a phoenix.

² *Lapidaires indiens*, p. XLVII.

variety of the stone which, struck by sunlight, instantaneously elicits fire, is styled *sūryakānti* by the connoisseurs. The physician Narahari from Kashmir, who wrote a small *lapidarium* in the beginning of the fifteenth century, observes in regard to the same stone, "If it is smooth, pure, without fissures and flaws in the interior, if polished so that it displays the clearness of the sky, and if from contact with solar rays fire springs from it, it is praised as genuine."¹ Narahari dilates likewise on the medical virtues of the stone, to which he lends the attribute "sacred," and which, if honored, procures the favor of the sun.

Fire-production by means of lenses was not a very ancient, or a common, or a popular, practice in India, any more than in classical antiquity.² In the oldest epoch of India's history, the Vedic period, we hear only of fire-making by means of friction from wooden sticks. The daily birth of Agni, the god of fire, from the two fire-sticks (*araṇī*), is often alluded to in Vedic literature.

¹ R. GARBE, *Die indischen Mineralien*, p. 89. Garbe commits the error of regarding this stone as the sunstone, being misguided by the Sanskrit name *sūryakānta*, and speculates that also the Indian name has come with this stone to Europe. All this is erroneous. First, the sunstone is not known to occur in India, but it occurs near Verchne Udinsk in Siberia, Tvedestrand and Hitterö in Norway, Statesville in North Carolina, and Delaware County in Pennsylvania (BAUER, *Edelsteinkunde*, 2d ed., pp. 528, 529); second, the name "sunstone" is bestowed upon this kind of feldspar by us, not by the Indians, because it reflects a spangled yellow light originating from minute crystals of iron oxide, hematite, or gothite, included in the stone, and which both reflect the light and give it a reddish color (FARRINGTON, *Gems and Gem Materials*, p. 179); this case, therefore, is totally different from that which induced the Hindu to name a certain variety of rock-crystal "sun-beloved;" third, feldspars, like the sunstone, are not made into burning-lenses, such as are described by Narahari. After arriving at his fantastic result, Garbe is forced to admit that Narahari is wrong to classify the (that is, Garbe's) "sunstone" among the quartzes; but the physician of Kashmir who does not speak of "our" sunstone is perfectly right in grouping rock-crystal among quartzes, and the blunder is solely on the part of Garbe.

² The utility of the burning-lens, of course, has its limitations. It is dependent upon a cloudless sky and the power of strong sunlight. At night when fire may be most needed it is put out of commission.

They are his parents, the upper being the male, and the lower the female; or they are his mothers, for he is said to have two mothers.¹ The *Vāyu Purāna*, one of the oldest of the eighteen Purānas, presumably dating in the first half of the fourth century,² mentions three kinds of fire, — the solar fire (*saura*), or the pure one, or the fire of the gods; fire proceeding from lightning, procured from trees ignited by a lightning-stroke; and fire obtained by friction. Whether and how the first-named was secured we do not know. It would be very tempting to believe that this celestial fire, obtained by concentrating the rays of the sun, was the result of an application of lenses, as, indeed, is still the case in Siam (see below). Such a conclusion, however, would hardly be justified. In all probability, only the divine or transcendental fire, like that in the Greek myth of Prometheus, is here intended. Also in the Avesta, the sacred writings of the ancient Iranians, in which five kinds of fire are distinguished, the fire of heaven burning in the presence of Ahura Mazda is known;³ and there is no record of the use of burning-lenses on the part of the Iranians.⁴

¹ Compare A. A. MACDONELL, *Vedic Mythology*, p. 91; H. OLDENBERG, *Religion des Veda*, p. 105; R. ROTH, *Indisches Feuerzeug* (*Z. D. M. G.*, Vol. 43, pp. 590—595); F. SPIEGEL, *Arische Periode*, p. 147. The modern processes of fire-making in India are well described by E. THURSTON, *Ethnographic Notes in Southern India*, pp. 464—470 (Madras, 1906).

² V. A. SMITH, *Early History of India*, p. 305 (3d ed., Oxford, 1914).

³ A. V. W. JACKSON, in *Grundriss der iranischen Philologie*, Vol. II, p. 641; W. GEIGER, *Ostiranische Kultur*, p. 253.

⁴ A material difference between the fire-worship of the ancient Indians and Iranians lies in the point that fire-making ceremonies predominate with the former (a good and succinct description of these will be found in the new book of L. D. BARNETT, *Antiquities of India*, pp. 156—161), while the latter were eager to seek for the sites of natural fire (JACKSON, *Zoroaster*, pp. 98—101); so that the artificial production of fire was not part of their rites. Much valuable information relative to the Persian worship of fire has been gathered by DIEULAFOY (*Suse*, pp. 393 *et seq.*). The Avesta (*Vidēvdāt*, xiv, 7; F. WOLFF, *Avesta*, p. 405) mentions fire-implements without description of particulars, and we seem to have no information as to Iranian methods of fire-making. This is the more deplorable, as the Persian form of fire-worship spread into all parts of the world, — to

In Sanskrit medical literature I have not yet found any reference to burning-lenses,¹ but the employment of burning-mirrors in medical practice is well ascertained for ancient India. Such mirrors, probably made of metal,² are twice mentioned in the medical work *Ashtāṅga-Hṛidaya*.³ In one case, certain drugs are to be ground on it; and a counterpart of this practice appears in a recipe of the famous Bower Manuscript, coming down from the middle of the fifth century: "Let long pepper and turmeric be rubbed repeatedly on a mirror, and anoint with them the eye when it suffers severe pain; it will then quickly become well." In the other case (mentioned in the above work), the wound of a person bitten by a rat is to be cured by an arrow or a mirror, and, as

Rome (F. CUMONT, *Mysteries of Mithra*, p. 99; and *Oriental Religions in Roman Paganism*, p. 137), to India (R. G. BHANDARKAR, *Vaishnavism*, pp. 151—155), and to China (Masudi, in B. de MEYNARD, *Prairies d'or*, Vol. I, p. 303; J. J. MODI, *References to China in the Ancient Books of the Parsees*, in his *Asiatic Papers*, pp. 241—254; CHAVANNES, *Le Nestorianisme*, *Journal asiatique*, 1897, pp. 60, 61, 74, 75; PELLIOU, *Bull. de l'Ecole française*, Vol. III, pp. 669, 670). It could very well be conceived that the Persian Magi, who appear in India under the name Maga and in China as Mu-hu (*Mémoires concernant les Chinois*, Vol. XVI, p. 230; CHAVANNES and PELLIOU, *Traité Manichéen*, p. 170), should have had a certain share in the diffusion of burning-lenses; but this, for the time being, remains purely a matter of speculation, as we are entirely ignorant of any evidence in the case. One curious coincidence, however, deserves attention in this connection, and this is the sacred caudle of the Siamese lighted with "celestial fire" by means of a burning-glass (mentioned below) and the same "celestial fire" kept constantly burning in a lamp by the Persian kings as a symbol of the perpetuity of their power; and it passed with the mystical ideas of which it was the expression to the Diadochi, and from them to Rome, where the celestial fire received as its emblem the inextinguishable fire that burned in the palace of the Cæsars, and which was carried before them in official ceremonies.

¹ Cauterization was practised by Indian physicians (see HOERNLE's translation of *Suśruta Samhitā*, pp. 74—80).

² Regarding mirrors in ancient India, see the writer's *Dokumente der indischen Kunst*, I, p. 174.

³ That is, the "Quintessence of the Eight Parts of Medicine," ascribed to the physician Vāghbata, probably written before the eighth century (J. JOLLY, *Indische Medizin*, p. 8; the time of the work is fully discussed by JOLLY in *Z. D. M. G.*, Vol. 54, 1900, pp. 260—274).

supposed by Dr. Hoernle, by the reflection of the sun-rays focussed on it.¹

The lack of information on objects of reality so painfully obtrusive in Indian literature, combined with the defect of a sound chronological sense, renders it impossible to trace a *terminus a quo* for the utilization of burning-lenses; and the records of the Chinese present our only reliable source in this respect. Indeed, the students of India have never taken up this problem, and may now hear for the first time that burning-lenses were ever known in India. The information coming from Chinese sources, which establish the date of the first introduction of such lenses into China in the beginning of the seventh century, allows the inference that they were made and employed in India prior to this date. This result, however trifling it may appear at first sight, is significant in bearing out the fact that long before the Arabic invasion of India (710) burning-lenses were operated there, and that the idea cannot have been imported into India by the Arabs.

Sacred fire was annually obtained from crystal lenses at the Court of the Emperor Akbar, and all the fires of the imperial household were lighted from it. His historian, Abul Fazl Allami (1551—1602), thus describes the ceremony:² "At noon of the day, when the sun enters the nineteenth degree of Aries, the whole world being then surrounded by its light, they expose to the rays of the sun a round piece of a white and shining stone, called in Hindi *sūrajkrānt*. A piece of cotton is then held near it, which catches fire from the heat of the stone. This celestial fire is committed to the care of proper persons. The lamp-lighters, torch-bearers, and cooks of the household use it for their office; and when the year has passed in happiness, they renew the fire. The vessel

¹ Compare A. F. R. HOERNLE, *The Bower Manuscript*, p. 160.

² H. BLOCHMANN, *Ain I Akbari*, Vol. I, p. 48 (Calcutta, 1873).

in which this fire is preserved is called 'fire-pot.' There is also a shining white stone, called *chandrkrānt*, which, upon being exposed to the beams of the moon, drips water."¹

Burning-lenses are still employed in Siam at state ceremonies, like the New Year festival, or during the tonsure-ceremonial when Buddhist monks are ordained, for obtaining what is called the "celestial fire" (*fai fa*). The medium enlisted is a huge wax candle, styled *thien chai* (literally, "victorious taper"), which is prepared under the direction of the head priest of some royal temple. The wax employed for a single taper amounts to twenty-six pounds in weight; the wick consists of a hundred and eight cotton threads, a number sacred with the Buddhists; and the length is about five feet. Round it are inscribed the magical formulas and diagrams which are prescribed by custom. This sacred candle is usually lighted by means of celestial fire, generated from the sun by the use of a huge burning-glass (*wen fai*) mounted on a richly gilded and enamelled frame. The fire thus kindled is protected in a lamp until the auspicious moment arrives for applying it to the "torch of victory." The lamp is then brought before the king, who takes

¹ The Hindi word corresponds to Sanskrit *candrakānta* ("beloved by the moon"), in the same manner as does *sūryakānta* to the above Hindi name for the crystal lens. *Candrakānta* is a kind of rock-crystal, generally believed in India to shed water when the moon shines on it (FINOT, *Lapidaires indiens*, p. XLVII). The Tibetan rendering of this term is *c'u šel* ("water crystal"), explained as "a fabulous magic stone supposed to have the power of producing water or even rain" (JÄSCHKE, *Tibetan-English Dictionary*, p. 562). GRENARD's opinion (*Mission scientifique dans la Haute Asie*, Vol. II, p. 407), that this stone "employed by the Tibetan sorcerers who have the power of causing or stopping rain" probably is jade, is inadmissible; the Tibetan word for "jade" is *yang-ti* or *g-yang-ti* (*Polyglot Dictionary of K'ien-lung*, Ch. 22, p. 64), the history of which I hope to trace some day in another place. — Tibetan has also a term for a burning-lens, — *me šel* ("fire crystal") or *sreg byed šel* ("burning crystal"); likewise Lepcha *mi šer* or *šer mi* (MAINWARING-GRÜNWEDEL, *Dictionary of the Lepcha Language*, pp. 285, 434). According to H. VON SCHLAGINTWEIT (*Reisen in Indien und Hochasien*, Vol. II, pp. 201, 202) burning-glasses imported from China are widely used in Tibet for fire-making; he himself witnessed in Sikkim the employment of such glasses directed on tinder.

a taper, termed the "ignition candle," which he lights at the celestial fire, while reciting a prayer-formula. The king then hands the ignition candle to the head priest, who applies its flame to the *thien chai*. During this performance the attendant chapter of monks rehearses a prayer. The torch is kept lighted in a special white gauze frame. A solemn ceremony takes place also at the time when it is extinguished.¹

ICE-LENSES. — Everybody knows that also a flake of ice, if cut into the form of a convex lens, may serve as a burning-glass with good effect. The Chinese have had this experience; and one of their books, the *Po wu chi* 博物志, a collection of notes on remarkable objects and occurrences, has it on record that "fire may be obtained by cutting a piece of ice into circular shape, holding it in the direction of the sun, and placing mugwort (*Artemisia*) behind the ice, so that it falls within the shadow."² It should be added that this notice figures under the title "juggler's art" 戲術; and it is from this class of performers, who swallow fire and swords, that the demonstration of such an experiment might be expected. Nevertheless, Li Shi-chên found it advisable to insert this notice in his essay on the mugwort,³ as if it had ever been a common practice of physicians to apply the moxa to their patients by means of an ice-lens. This, however, remains open to doubt. Mugwort is said to have received the name "ice-terrace" (*ping-t'ai*) from the employment of ice-lenses. The authorship of the work above quoted is attributed to Chang Hua 張華, who lived from 232 to 300. If Chang Hua of the third century should really have written this

¹ After G. E. GERINI, *The Tonsure Ceremony as performed in Siam*, p. 161 (Bangkok, 1893). — Regarding crystal lenses in Japan see GEERTS, *Produits de la nature japonaise et chinoise*, p. 243.

² 削冰令圓舉以向日以艾於後承其影則得火 (Ch. 4, p. 4b; edition printed in Wu-ch'ang).

³ *Pên ts'ao kang mu*, Ch. 15, p. 3.

passage, the case would indeed be notable in establishing the fact that four centuries prior to the first introduction of burning-lenses from Indian regions the latter were known in China as an apparently native idea. Indeed, this text has been accepted in this sense, and was marched forward by G. SCHLEGEL¹ as a strong bulwark in his argumentation for the indigenous origin of burning-lenses in China; but this plea will melt away as easily as the bit of ice when its function as lens was over. Also Schlegel had access to WYLIE's *Notes on Chinese Literature*, from which we learn (p. 192) that the work *Po wu chi*, originally drawn up by Chang Hua, was lost in the Sung period (960—1278); that the present book with that title was probably compiled at a later period on the basis of extracts contained in other publications; and that there are many quotations from it in the ancient literature which do not appear in the modern edition. There is, accordingly, no guaranty whatever that any text in this work, as it is now extant, goes back to the third century and originates from the hand of Chang Hua. The text in question is quoted by Li Shi-chên from the *P'i ya* 埤雅, a dictionary compiled by Lu Tien 陸佃 (1042—1102), so that from this indication we may carry it to the latter part of the eleventh century. It is certainly far older than that; but it cannot have been penned by Chang Hua, and, at the very best, cannot date back farther than the first half of the seventh century, when burning-lenses first became known in China. The Annals of the T'ang Dynasty, as we noticed, record burning-lenses in the possession of the Lo-ch'a as an entirely novel affair, describing their use and effect, and this incontrovertibly proves that they were unknown in times previous. Neither do the T'ang

¹ *Uranographie chinoise*, p. 142; *Nederlandsch-Chineesch Woordenboek*, Vol. I, p. 674; and *T'oung Pao*, Vol. IX, 1898, p. 179. The allegation of Schlegel that lenses of ice were used before the invention of glass is pure invention, being contained neither in this nor in any other Chinese text.

authors assert that they were known at an earlier date (Yen Shiku, on the contrary, insists on their being imported "at present;" that is, in his own lifetime), nor is there any record in the historical annals relating to the third century to the effect that such lenses should have been in vogue at that period. Whoever reads with critical eyes the account now sailing under the false flag of the *Po wu chi* will soon notice that in its style it is worded on the basis of the text of the T'ang Annals, and also that it materially depends upon the latter, — materially, because it was only after, and in consequence of, the introduction of foreign crystal lenses, that the experiment with ice could have been conducted in China. This idea was not conceived by the Chinese as the result of a natural observation or optical study, which they never cultivated; but ice was resorted to as a makeshift, as a substitute for the costly rock-crystal, on the theory of their nature philosophy, that the latter is transformed ice: crystal and ice, being products of a like origin, were thought to be able to bring about the same effect.

CONCLUSIONS. — When we now attempt to reconstruct the general history of burning-lenses, the principal fact standing out is that China, despite the opposite contention of some enthusiasts, has not the shadow of a claim to their invention, but, on the contrary, admits her debt to Lo-ch'a and Champa; that means, to India. China received them from India in the same manner as mediæval Europe and the Arabs received them from Greece and Rome. The problem, therefore, crystallizes around the central point: In what reciprocal relation or obligation are India and Hellas? Hellas, at the outset, is entitled to the privilege of chronological priority, and

can point to the well-fixed date 423 B.C., when Aristophanes wrote his *Clouds*. At that time, we may assert positively, burning-lenses were unknown in India, for which we have merely a retrospective *terminus a quo* lying backward of the seventh century A.D. Negative evidence in this particular case is somewhat conclusive: for, with all their ideas of the sacredness of fire and its prominent position in religious worship, the ancient Hindu themselves would not have allowed such an excellent contrivance to escape, — a contrivance that would have brought the realization of their dreams of celestial fire. The fact remains that none of the Sanskrit rituals ever mention such an implement, which, for this reason, cannot have been of any significance in the culture-life of the nation. It is therefore highly improbable, nay, impossible, that the Hindu should have independently conceived the invention. Even if our conclusion, based on Chinese documents, that burning-lenses were employed in India prior to the seventh century, should be substantiated in the future by the efforts of Indian research, and, for example, be carried back to a few centuries earlier, this would hardly change our result fundamentally, or overthrow the impression that the use of such lenses belongs to the mediæval epoch of Indian history. There are good reasons for upholding this opinion and for connecting their introduction with the influence upon India of Hellenistic-Roman civilization. First, we may say negatively that it was not Assyria which transmitted the idea to India. In that case, we should justly expect that it would turn up there at a much earlier date, and occur simultaneously in ancient Persia; but Zoroastrian Persia, like Vedic India, lacks them entirely. This observation justifies us in concluding also that burning-lenses played a

very insignificant part, if any, in Mesopotamia; if they did, we should find them also in Greece at a much earlier date. Without pressing the question of the when and where of the original invention, we must be content at present to regard the Greeks as the people who, we know positively, made the first use of optical lenses. The second negative evidence that is impressed upon us is this, that Alexander's campaign cannot be made responsible for the transmission. It is needless to insist that the historians of Alexander are silent about it; coeval India is likewise so; and it is inconceivable that an idea, though Alexander's genius should have carried it into the borders of India, would have borne fruit on her soil only as late as the middle ages. The Arabs, as already observed, did not transfer it, either, to India. If we strictly adhere to our chronological result, we are clearly carried into the Gupta period, which, taken in a wide sense, extends from about 300 to 650 A.D., and which, particularly in the fourth and fifth centuries, was a time of exceptional intellectual activity in many fields,¹ in mathematics, astronomy, and medicine, all of which have received an appreciable stamp of Western influence.² Indeed, as emphasized by Smith, the eminent achievements of this period are mainly due to contact with foreign civilizations, both on the East and on the West, and the fact of India's intercourse with the Roman Empire is indisputable. The conquest of Mālwa and Surāshtra by Candragupta II Vikramāditya toward the close of the fourth century opened up ways of communication between Upper India and Western lands which

¹ V. A. SMITH, *Early History of India*, 3d ed., p. 304.

² See particularly A. WEBER, *Die Griechen in Indien* (*Sitzungsberichte Berliner Akademie*, 1890, pp. 921—925); G. D'ALVIELLA, *Ce que l'Inde doit à la Grèce*, pp. 95—119 (Paris, 1897); G. THIBAUT, *Indische Astronomie*, pp. 43, 76.

gave facilities for the reception of European ideas. It is accordingly a reasonable conclusion that burning-lenses were transmitted to India, not from Hellas, but from the Hellenistic Orient of the Roman Empire, in a period ranging between the fourth and sixth centuries, to be passed on to China in the beginning of the seventh century. The introduction of the burning-mirrors alluded to in the Bower Manuscript, in my opinion, falls within the same epoch, emanating from the same direction.

ADDITIONAL NOTES. — P. 202, note 2. The tree in question is the *pārijāta* (see *Fan yi ming i tsi*, Ch. 25, p. 27 b, ed. of Nanking).

P. 206, note. Compare also *lang-tang* 琅璫 and 銀鐺; an interesting notice on this word is contained in the *Néng kai chai man lu*, Ch. 7, p. 27 b (*Shou shan ko ts'ung shu*, Vol. 71).

The interesting study of Dr. M. W. de Visser (*Fire and Ignis Fatui in China and Japan*, reprint from *M.S.O.S.*, 1914, pp. 97—193) reached me only a short while ago when my manuscript was in the press. Dr. de Visser touches some questions dealt with on the preceding pages, though from a different point of view, but he accepts Schlegel's statements and the text of the *Po wu chi* without criticism.



Ostrich Egg-shell Cups of Mesopotamia and the Ostrich in Ancient and Modern Times

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Ostrich Egg-shell Cups of Mesopotamia
and the Ostrich in Ancient and
Modern Times

BY
BERTHOLD LAUFER
CURATOR OF ANTHROPOLOGY

9 Plates and 10 Text-figures



ANTHROPOLOGY
LEAFLET 23

FIELD MUSEUM OF NATURAL HISTORY
CHICAGO
1926

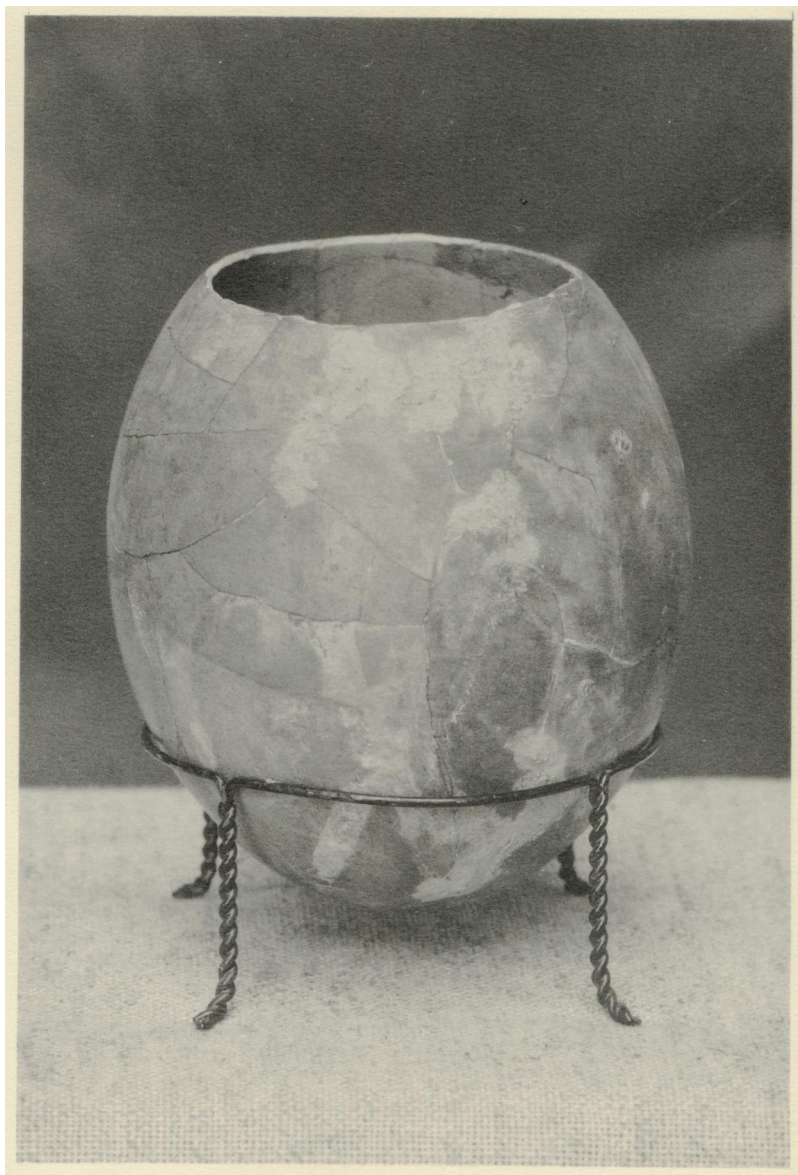
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1. The Chinese Gateway	\$.10
2. The Philippine Forge Group10
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5. The Thunder Ceremony of the Pawnee25
6. The Sacrifice to the Morning Star by the Skidi Pawnee10
7. Purification of the Sacred Bundles, a Ceremony of the Pawnee . . . . .	.10
8. Annual Ceremony of the Pawnee Medicine Men . . . . .	.10
9. The Use of Sago in New Guinea . . . . .	.10
10. Use of Human Skulls and Bones in Tibet . . . . .	.10
11. The Japanese New Year's Festival, Games and Pastimes . . . . .	.25
12. Japanese Costume . . . . .	.25
13. Gods and Heroes of Japan . . . . .	.25
14. Japanese Temples and Houses . . . . .	.25
15. Use of Tobacco among North American Indians . . . . .	.25
16. Use of Tobacco in Mexico and South America . . . . .	.25
17. Use of Tobacco in New Guinea . . . . .	.10
18. Tobacco and Its Use in Asia . . . . .	.25
19. Introduction of Tobacco into Europe . . . . .	.25
20. The Japanese Sword and Its Decoration . . . . .	.25
21. Ivory in China . . . . .	.75
22. Insect Musician and Cricket Champions of China (in press)	
23. Ostrich Egg-shell Cups of Mesopotamia and the Ostrich in Ancient and Modern Times . . . . .	.50

D. C. DAVIES
DIRECTOR

FIELD MUSEUM OF NATURAL HISTORY
CHICAGO, U. S. A.



OSTRICH EGG-SHELL CUP FROM GRAVE AT KISH, MESOPOTAMIA (p. 2).
ABOUT 3000 B.C. IN FIELD MUSEUM.

About one-third actual size.

FIELD MUSEUM OF NATURAL HISTORY
DEPARTMENT OF ANTHROPOLOGY
CHICAGO, 1926

LEAFLET

NUMBER 23

Ostrich Egg-shell Cups of Mesopotamia
and the Ostrich in Ancient and
Modern Times

CONTENTS

	Page
The Ostrich in Mesopotamia.....	2
The Ostrich in Palestine, Syria, and Arabia.....	9
The Ostrich in Ancient Egypt.....	16
The Ostrich in the Traditions of the Ancients....	21
The Ostrich in the Records and Monuments of the Chinese	29
The Ostrich in Africa.....	34
The Domestication of the Ostrich.....	41
The Ostrich in America.....	47
Bibliographical References	51

THE OSTRICH IN MESOPOTAMIA

In his "Report on the Excavation of the 'A' Cemetery at Kish, Mesopotamia" published by Field Museum (Memoirs, Vol. I, No. 1), Ernest Mackay writes as follows: "A rare object found in grave 2 was a cup which had been made from an ostrich shell by cutting about one-third of the top of the shell away and roughly smoothing the edge. It was the only one of its kind found in the cemetery, and it was in such a very bad condition with so many pieces missing that it could neither be restored nor drawn. The remains of a similar cup were found in one of the chambers of a large building of plano-convex bricks, about a mile from the 'A' cemetery, which appears to be of the same date. The ostrich is still found in the Arabian desert, and was doubtless plentiful in early times. Its feathers as well as its eggs were utilized by the ancients."

In the course of further excavations on the ancient sites of Kish great quantities of fragments of ostrich egg-shell were brought to light and, together with other collections, mainly pottery, stone, and metal, were recently received in the Museum. Having read in Chinese records of ostrich eggs anciently sent as gifts from Persia to the emperors of China and being aware of the importance of this subject in the history of ancient trade, I took especial interest in these egg-shell fragments and induced T. Ito, a Japanese expert at treating and repairing antiquities, to restore three of these cups completely. The result of his patient and painstaking labor is shown in Plates I and II illustrating two of the cups. These restorations are true and perfect; that is, they consist of some eighty shards each, accurately and perfectly joined, without the use of other substances or recourse to filling-in. Thanks to

the admirable skill of Mr. Ito we now have these beautiful cups before us, exactly in the shape, as they were anciently used by the Sumerians. These cups, almost porcelain-like in appearance, have the distinction of representing the oldest bird-eggs of historical times in existence, and may claim an age of at least five thousand years. Being the eggs of the majestic winged camel of the desert, the largest living bird, the fleetest and most graceful of all running animals that "scorneth the horse and his rider," they are the only eggs of archæological and historical interest. But they are more than mere eggs; they are ingeniously shaped into water-vessels or drinking goblets by human hand, a small portion at the top having been cut off and the edge smoothed. They were closed by pottery lids overlaid with bitumen, one of the oldest pigments used by mankind. They are thus precious remains of the earliest civilization of which we have any knowledge. In Plate III single fragments of egg-shell are shown, as they came out of the graves, and some patched together from several pieces. These are decorated with banded zones of brown color brought out by means of bitumen. The shell is extremely hard and on an average 2 mm thick.

The trade in ostrich eggs was of considerable extent and importance in the ancient world. They have been discovered in prehistoric tombs of Greece and Italy, in Mycenæ (Fig. 3), Etruria (Fig. 9), Latium, and even in Spain, in the Punic tombs of Carthage as well as in prehistoric Egypt. We find them in ancient Persia and from Persia sent as tribute to the emperors of China. The Spartans showed the actual egg of Leda from which the Dioscuri, Castor and Pollux, were said to have issued; there is no doubt that the egg of an ostrich rendered good services for this pious fraud. In 1833, Peter Mundy, an energetic English traveler, saw ostrich (or, as he

spells, estridges) eggs hung in a mosque in India. In 1771, General Sir Eyre Coote found the cupola of a Mohammedan tomb fifty miles north-east of Palmyra adorned with ostrich eggs, and at present also, devout Moslems of the Near East are fond of honoring the sepulchre of a beloved dead with such an egg which is suspended from a tree or shrub on the burial place. Even in the Christian churches of the Copts they are reserved for the decoration of the cords from which the lamps are suspended.

Pliny writes that the eggs of the ostrich were prized on account of their large size, and were employed as vessels for certain purposes. The eggs were also eaten and found their way to the table of the Pharaohs. The Garamantes, a group of Berber tribes in the oases of the Sahara south of Tripolis, anciently had a reputation for being fond of the eggs. Peter Mundy (1634) found ostrich eggs, whose acquaintance he made at the Cape of Good Hope, "a good meate." The egg is still regarded as a rare delicacy in Africa. The contents of one egg amounts to forty fluid ounces, and in taste it does not differ from a hen's egg. An omelet prepared from one egg is sufficient for eight persons. Cuvier, the French naturalist, remarks that an ostrich egg is equal to twenty-four to twenty-eight fowl's eggs, and that he had frequently eaten of them and found them very delicate.

Arabic poetry is full of praise for the beauty of ostrich eggs, and the delicate complexion of a lovely woman is compared with the smooth and brilliant surface of an ostrich egg. The Koran, in extolling the bliss and joys of Paradise, speaks of "virgins with chaste glances and large, black eyes which resemble the hidden eggs of the ostrich."

The thickness of the egg-shell in the African species (*Struthio camelus*) varies from 1.91 to 1.98 mm; the length of the eggs from 140.01 to 156.75 mm, the

width from 121.02 to 138 mm. In *Struthio molybdophanes* (so called from the leaden color of its naked parts) of the Somali country, the egg-shell is even 2.02 mm thick; the length varies from 145 to 159.95 mm, the width from 119.50 to 125.4 mm. The weight of the full eggs is from one to two thousand grams, that of the empty ones varies from 225 to 340 grams.

The eggs of birds living in captivity differ considerably from those of wild birds, both in size, coloration, and structure. The former are frequently larger and more oblong, and have a thin shell; the colors are more lively, and the enamel layer is flat, sometimes entirely obliterated.

The egg of a domesticated ostrich from a Californian farm, 163 mm in length, is shown for comparison in Plate IV. As the Californians are all descendants of birds imported from South Africa, their eggs exhibit to a marked degree the pitting which is characteristic of the South African species and which is associated with the respiratory pores of the shell. In the egg-shell of the North African bird, according to J. E. Duerden, the pores are so small and open so close to the surface, as to be scarcely visible to the naked eye, and are mostly scattered singly, with but little grouping, hence the surface appears almost uniformly smooth. In the southern egg, the shell pores are larger, sunken below the general surface, and mostly in small groups, varying from about six to twelve in a group. It is the close grouping of the sunken pores which give rise to the pitted surface. In both types the outer enamel layer shows differences in thickness, and with it the polished character of the surface. All the eggs are a cream or yellow color when freshly laid, but fade considerably on exposure and harden in course of time.

The egg of the North African bird is larger than that of the southern, the shell is almost free from pores or pittings, and presents an ivory-like smooth surface.

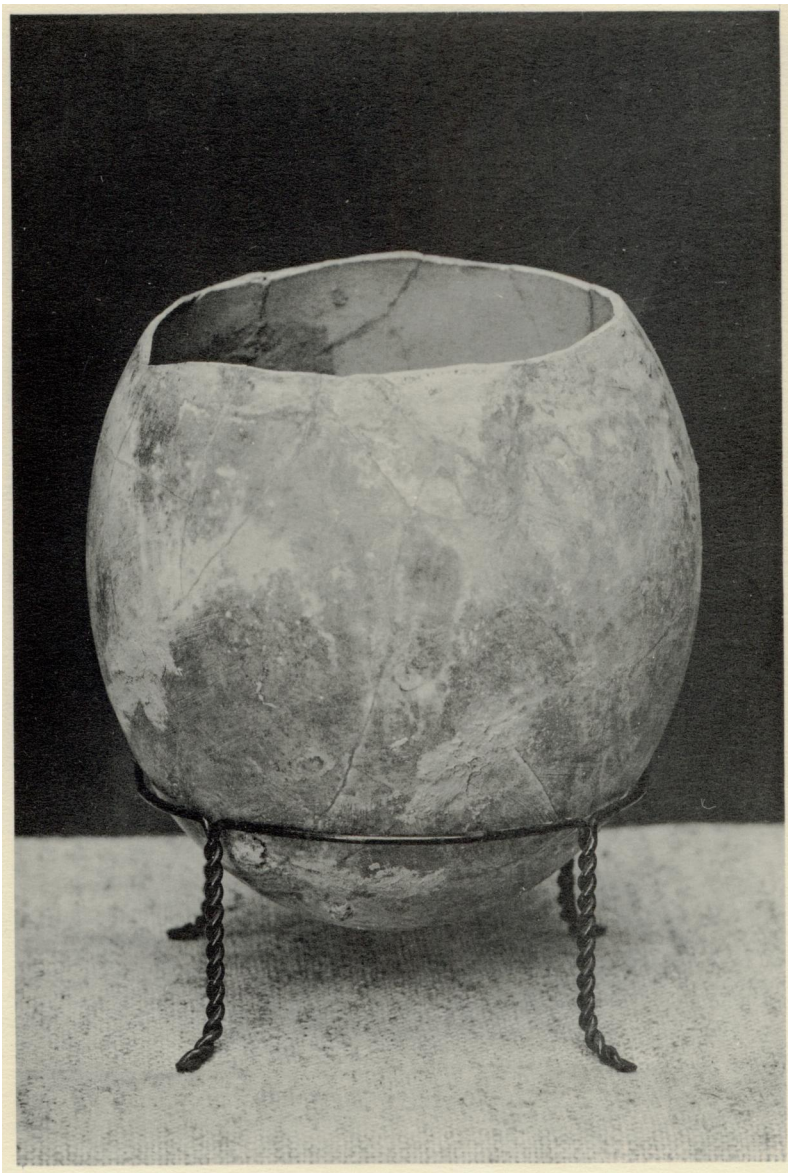
The northern egg is usually rounded in shape and less oval. The egg of the southern bird is deeply pitted all over the surface, the pits often larger and more plentiful at the air-chamber end, hence the shell does not present the ivory smoothness of the northern egg. According to J. E. Duerden, who has devoted a special investigation to the two varieties, no mistake is possible in discriminating the one type from the other in a mixed lot of eggs from northern and southern birds.

In cases where the North African hen was mated with the South African cock, a peculiar feature was noted, namely, that the egg-shells of this cross-breed were only pitted in certain patches, while other patches were quite smooth.

In our Mesopotamian eggs the pores are exceedingly fine, and for this reason it may be concluded that the species represented by them is identical with, or closely allied to the present Syrian and North African ostriches. The latter extends right across the Sahara from the Sudan and Nigeria to Tunis and Algeria and from Senegal eastwards. The egg of the Syrian species, if a distinct species it is, is said to be of smaller size and higher polish than the North African one.

In ancient Elam rows of ostriches are found depicted on early pottery, closely resembling the ostriches on the pre-dynastic pottery of ancient Egypt.

In 1849 Austen H. Layard (Nineveh and Its Remains) wrote, "The only birds represented on the Assyrian monuments hitherto discovered are the eagle or vulture, the ostrich and the partridge, and a few smaller birds at Khorsabad, whose forms are too conventional to permit of any conjecture as to their species. The ostrich was only found as an ornament on the robes of figures in the most ancient edifice at Nimrud. As it is accompanied by the emblematical flower, and is frequently introduced on Babylonian and Assyrian cylinders, we may infer that it was a sacred



OSTRICH EGG-SHELL CUP FROM GRAVE AT KISH, MESOPOTAMIA (p. 2).
ABOUT 3000 B.C. IN FIELD MUSEUM.

About one-third actual size.

bird." The statement that the ostrich is represented on an Assyrian king's robe is repeated by Perrot and Chipiez, Handcock, and Meissner; but this bird, in my



FIG. 1.

Assur Strangling Two Ostriches. Engraved on an Assyrian Seal-cylinder.
After Dorow.

opinion, is not an ostrich; it has a short neck, and its head is entirely different from that of an ostrich. The fact, however, remains that the latter is clearly represented on seals and cylinders.



FIG. 2.

The God Marduk Executing an Ostrich. Engraved on an Assyrian Seal-cylinder.
After W. Houghton.

One of these seals is shown in Fig. 1. It was the seal of Urzana, king of Musasir, a contemporary of King Sargon (eighth century B.C.), and represents

Assur, king of the great Assyrian gods, with four wings, in the act of strangling two ostriches. On another seal (Fig. 2) the god Marduk is shown in the act of executing vengeance on an ostrich. With his left hand he firmly grasps the bird's long neck, and in his right he holds a scimitar which will apparently be used to sever the bird's head. These illustrations apparently hint at a ritual act and seem to indicate that the ostrich was also a sacrificial bird and that its flesh was solemnly offered to the gods. Perrot and Chipiez (*History of Art in Chaldea and Assyria*, II, p. 153) figure a scene from a chalcedony cylinder in Paris, which represents an ostrich about to attack a man with outspread wings and raised left foot; the man tries to lure the bird with a fruit which he holds in his right hand, while behind his back he hides a deadly scimitar in his left.

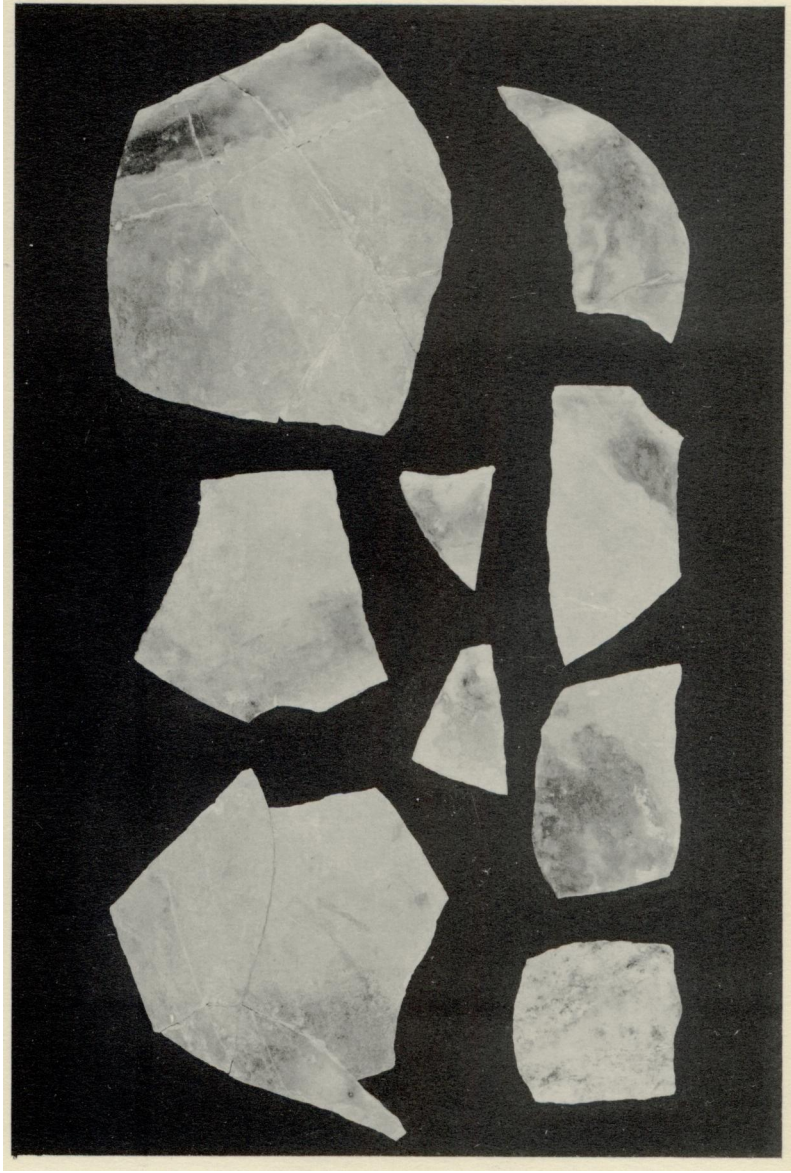
In the language of the Sumerians the ostrich was known under the names *gir-gid-da*, which is explained as "the long-legged bird" and *gam-gam*, which means as much as "benefactor" or "well disposed." The latter name was borrowed by the Assyrians in the form *gam-gam-mu*. Other Assyrian designations of the bird are *sha-ka-tuv* and *se-ip-a-rik*, the latter also meaning "long-legged."

THE OSTRICH IN PALESTINE, SYRIA, AND ARABIA

The ostrich was well known to the Hebrews, and as attested by several allusions to the bird in the Old Testament, must in ancient times have been frequent in Palestine. It is included among unclean birds in the Mosaic code (Leviticus XI, 16; Deuteronomy XIV, 15), and its flesh was prohibited. This may hint at the fact that the ostrich had occasionally served as food to the Hebrews, although we have no positive information on this point. The reason for the interdiction is not revealed. The ancient apostolic fathers explain that it was forbidden, because the ostrich cannot rise from the earth; modern commentators, because it is a voracious animal and hunting it is cruel. Those who assert that it was abhorred as an exotic animal in Palestine err in a point of zoogeography. The simplest interpretation seems to be that, like other unclean animals of the Mosaic legislation, it was tabooed by Moses, because the surrounding pagan nations availed themselves of its flesh both as a sacrifice to their gods (see above, p. 8) and for their own use. The Arabs of ancient and modern times feast on the bird, and as related by Leo Africanus of the sixteenth century, its flesh was consumed to a large extent in Numidia, where young birds were captured and fattened for this purpose. There are other tribes like the Shilluks of the Sudan who for superstitious reasons abstain from ostrich flesh. Those who have tasted it state unanimously that it is both wholesome and palatable, although in the wild bird, as might be expected, it is somewhat lean and tough. The meat of domesticated birds, however, especially those fed on alfalfa and grain, becomes juicy and tender. Dr. Duncan of the Department of Agriculture recommends it as a New Year or Easter bird.

Job (xxx, 29) laments, "A brother I have become to the jackals, and a companion to the young ostriches." And the prophet Micah (i, 8) exclaims in a similar vein, "Like jackals will I mourn, like ostriches make lamentation." The comparison alludes to the plaintive voices of these animals. The jackal and ostrich are again combined in a passage of Isaiah (xxxiv, 13): "And it shall be an habitation of jackals, and a court for ostriches." The cry of the ostrich has been described variously by observers: some define it as a loud, mournful kind of bellowing roar, very like that of a lion; others define the common sounds of the cock as a dull lowing which consists of two shorter tones followed by a longer note; in a state of excitement he will give a hissing sound, and his warning cry is an abrupt, shrill note. The Hebrew word *renanim* used for the female ostrich means literally "cries, calls," and refers to the twanging cry of the female. Another designation of the ostrich, *bath haya'anah*, signifies literally "daughter of the desert"; that is to say, a desert-dweller, a very appropriate name for the bird. A parallel term occurs in Arabic with the meaning "father of the desert." Isaiah (xiii, 21), in his prediction of the fate of Babylon, says, "But wild beasts of the desert shall lie there; and their houses shall be full of doleful creatures; and ostriches shall dwell there, and satyrs shall dance there."

The famous passage in Job (xxxix, 13-18) is thus rendered in the Revised Version: "The wing of the ostrich rejoiceth; but are her pinions and feathers kindly (or, as the stork's)? which leaveth her eggs in the earth, and warmeth them in dust, and forgetteth that the foot may crush them, or that the wild beast may break them. She is hardened against her young ones, as though they were not hers: her labour is in vain without fear; because God hath deprived her of wisdom, neither hath He imparted to her understand-



OSTRICH EGG-SHELL FRAGMENTS PAINTED WITH BITUMEN, FROM GRAVE AT KISH, MESOPOTAMIA (p. 3). IN FIELD MUSEUM.
About one-half actual size.

ing. What time she lifteth up herself on high, she scorneth the horse and his rider."

The text is difficult, especially in the opening paragraph, and various translations have been proposed, thus, for instance: "The wing of the ostriches is raised joyfully; but is it a pinion and feather as kindly as that of the stork? No, the ostrich hen leaves her eggs to the earth," etc.

Professor J. M. Powis Smith of the University of Chicago has been good enough to communicate to me his own translation prepared for his coming version of the Old Testament. It runs thus:

Is the wing of the ostrich joyful,
Or has she a kindly pinion and feathers,
That she leaves her eggs on the ground,
And warms them on the dust,
And forgets that the foot may crush them,
Or the beast of the field trample them?
She is hard to her young, as though not her own;
For nothing is her labour; she has no anxiety.
For God has made her oblivious of wisdom,
And has not given her a share in understanding.
When she flaps her wings aloft,
She laughs at the horse and his rider.

According to those scholars who translate the word *chasidah* by "stork," the Hebrew poet contrasts the ostrich with the stork. The stork, as indicated by its name *chasidah* ("the pious one"), was the symbol of kindness and piety, and was regarded as a model of filial love; for this reason it is venerated by all Oriental peoples. The ostrich may resemble the stork in some respects, but differs from it in the care for its young. The description that follows is based on the widely spread, but erroneous assumption that the ostrich is in the habit of leaving its eggs in the sand to be hatched by the sun. The Hebrew poet is intent on making the point that in spite of the careless treatment of the eggs the bird is propagated as a striking evidence of God's constant solicitude for his creatures. To make amends

for the lack of wisdom, fleetness of foot has been granted the ostrich. In case its life is endangered, it leashes the air with its wings which assist in running, and derides horse and rider who are in pursuit of it,—a sign that the ostrich, after all, is not so stupid.

The alleged cruelty of the ostrich to its young is also referred to in the passage, "Even the sea monsters draw out the breast, they give suck to their young ones: the daughter of my people is become cruel, like the ostriches in the wilderness" (Lamentations IV, 3).

The observation made in the book of Job that the ostrich treats her offspring harshly does not conform with the real facts. The birds, on the contrary, are tender parents and feed and watch their young ones very carefully. The eggs are laid in a shallow pit or depression of the soil scraped out by the feet of the old birds with the earth heaped around to form a wall or rampart. The female incubates the eggs during the day, while the male takes her place at night. As eggs are sometimes dropped in the neighborhood of the nest or scattered around, the popular belief in the carelessness of the birds and in the hatching of the eggs by the heat of the sun may have arisen. Any eggs not hatched are broken by the parents and fed to the young for whom they display great solicitude, and whom they defend in case of danger.

As to Palestine, the ostrich still occurs in the farther parts of the Belka, the eastern plains of Moab, and is still obtained near Damascus. It is no doubt now but a straggler from central Arabia, though formerly far more abundant (Tristram, *Fauna and Flora of Palestine*). The portion of the Syrian desert lying east of Damascus denotes the northernmost limit of the range of the ostrich. According to Burckhardt, it inhabits the great Syrian Desert, some being found in Hauran, and a few being taken almost every year, even within two days' journey from Damascus.

As regards ancient Syria, the ostrich is attested by relief-pictures in the theatre at Hierapolis of Roman times, one of these depicting a lioness seizing an ostrich by the neck, and by its introduction into the Syriac version of the Physiologus.

In the Physiologus, a Greek allegorical natural history, which originated at Alexandria in the second century of our era, the following story is told: "The ostrich looks up to heaven in order to see when her time has come to lay her eggs. She does not lay before the Pleiades rise, at the time of the greatest heat. She lays her eggs in the sand and covers them with sand; thereupon she goes away and forgets them, and the heat of the sun hatches them in the sand. Since the ostrich knows her time, man ought to know his to a still higher degree: we have to look up toward heaven, forget worldly existence, and follow Christ."

This story has doubtless been formed by combining Job XXXIX, 14, with Jeremiah VIII, 7 ("the stork in the heaven knoweth her appointed time"). From the Hebrew name of the stork, *chasidah*, the Greek text of the Physiologus has derived the word *asida* in the sense of ostrich. In mediæval Europe the notion still prevailed that the ostrich hatches her eggs merely by glancing at them or by the steadfast gaze of maternal affection. In consequence of this imaginary exploit the bird was chosen as an emblem of faith.

The great outlets from Syria for the ostrich plumes are Aleppo, Damascus, and Smyrna, where the bazars always contain a good supply.

The Janizaries of Turkey who had excelled in battle had the privilege of adorning their turbans with an ostrich feather. At the time of the Ottoman empire there was an imperial ostrich-park in Beylerbey Serai on the Bosphorus.

From times immemorial the ostrich has been an inhabitant of Arabia. Heraclides and Xenophon, sub-

sequently Agatharchides and Diodorus mention it as a native of the peninsula. The valuable white plumes of the wings and tail are in great demand among the Arabs for their own wants in the decoration of tents and spears of the sheikhs. Ostrich hunting is alluded to in early Arabic poetry, and has always been a popular sport with the Arabs, who rely on the speed of their horses and run the birds down. As these are in the habit of circling their favorite haunts, the horsemen hunt in relays, and are apt to overtake the birds by pursuing in a straight line.

Kazwini (1203-83), the Arabic author of a Cosmography in which a section is devoted to animals, tells this story: "When the ostrich has laid her eggs, twenty in number or more, she buries them under the sand, leaving one third in one place, exposing another third to the sun, and hatching another third. When the chicks have come out, she breaks the hidden eggs and feeds her young with them. And when the chicks have grown strong, she breaks the last third on which vermin will collect, and this serves as food for the young until they are able to graze." There is a germ of truth underlying this story, and this is that the old birds feed their young on the contents of eggs which they trample down for them. When the eggs are left during the heat of the day, they are covered up with sand, and the occasional finding of such eggs may have given rise to Kazwini's story. He relates another anecdote to the effect that the ostrich, when it has withdrawn from its own eggs and spies other birds' eggs, will hatch the latter and desert its own.

There is a Moslem legend in explanation of the bird's inability to fly. "Once upon a time the ostrich was winged, and like other birds, was capable of flight. He once laid a wager with the bustard, but relying on his strength he forgot before rising to invoke Allah's assistance. He flew in the direction of the sun which

scorched his pinions, so that he pitifully plunged down to earth. His progeny has since suffered from the curse which befell its ancestor, and restlessly roves about in the desert."

The Arabs have many names for the ostrich like camel-bird, father of the desert, the magician, the strong one, the fugitive one, the stupid one, and the gray one (for a young bird). Ostrich fat is regarded as a powerful remedy for both external and internal use.



FIG. 3.

Engraving on an Ostrich Egg from Mycenae, Greece.
After Perrot and Chipiez.

THE OSTRICH IN ANCIENT EGYPT

The ancient Egyptians received the ostrich and its products from Nubia, Ethiopia, and the country Punt on the east coast of Africa. An expedition to Punt, probably of a peaceful nature, is recorded on the wall connecting the two Karnak pylons of King Harmhab of the nineteenth dynasty. A relief shows the king at the right, holding audience, receiving the chiefs of Punt approaching from the left, bearing sacks of gold dust, ostrich feathers, etc. (Breasted, *Ancient Records of Egypt*, III, 37).

In the rock temple of Abu Simbel are represented scenes depicting a war of Ramses II against the Libyans and the Nubian war. In one of these scenes Ramses sits enthroned on the right side; approaching from the left are two long lines of Negroes, bringing furniture of ebony and ivory, panther hides, gold in large rings, bows, myrrh, shields, elephants' tusks, billets of ebony, ostrich feathers, ostrich eggs, live animals, including monkeys, panthers, a giraffe, ibexes, a dog, oxen with carved horns, and an ostrich (Breasted, *op. cit.*, III, 475).

Fig. 4 illustrates a very instructive Egyptian scene. The man on the left leads a captured ostrich, grasping its neck with his right hand, while his left holds a rope slung around the bird's neck; this double precaution hints well at the strength of the powerful avian giant. The man on the right carries three ostrich feathers and a basket filled with three ostrich eggs. The ostrich was sometimes used as a riding-beast, as may be seen from the scene in Fig. 5. Oppianus remarks that it can easily carry a boy on its back. Heuglin says that the possibility of riding the ostrich has often been doubted, but he assures us that the animal is able to carry a heavy man, but not for a long

time, and after a brief run will throw itself on the ground. A prehistoric serpentine figure of a seated ostrich is illustrated by Flinders Petrie (*Amulets*, No. 246).

Ostrich eggs showing traces of painting and engraving have been found in prehistoric tombs of Egypt, and are figured by Jean Capart (*Primitive Art in Egypt*, p. 40). They were also imitated in clay and decorated with black zigzag lines in imitation of cords or simply painted with white spots. In the Egyptian department of the British Museum is shown an enor-

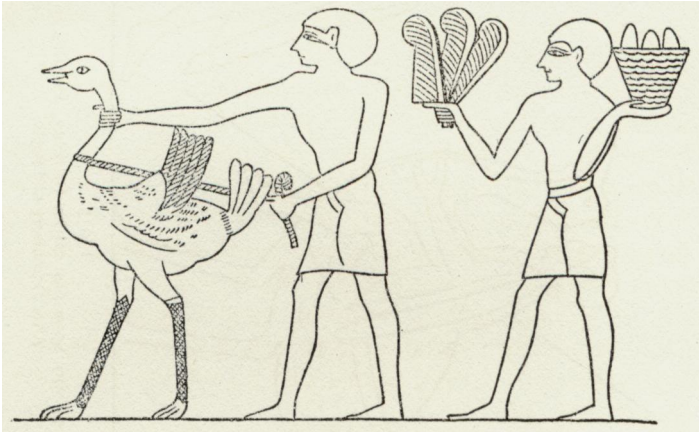


FIG. 4.

Egyptian Scene Showing a Captured Ostrich and Man with Ostrich Feathers and Eggs.
After O. Keller.

mous marble egg which is apparently intended for an enlarged ostrich egg, and which was once deposited in a sacred place. During the historic period, ostrich eggs and feathers were imported from the land of Punt and probably also from Asia.

Imitations of ostrich eggs in terracotta have been found in the tombs of Vulci in Italy, which, according to G. Dennis (*Cities and Cemeteries of Etruria*), seems to indicate that the demand was greater than the supply.

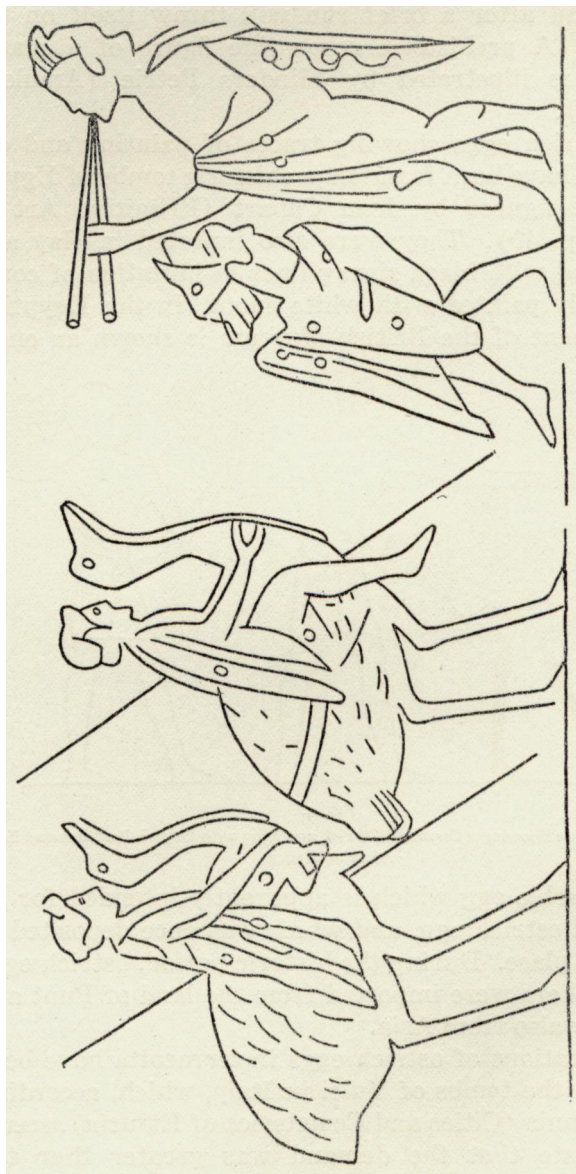
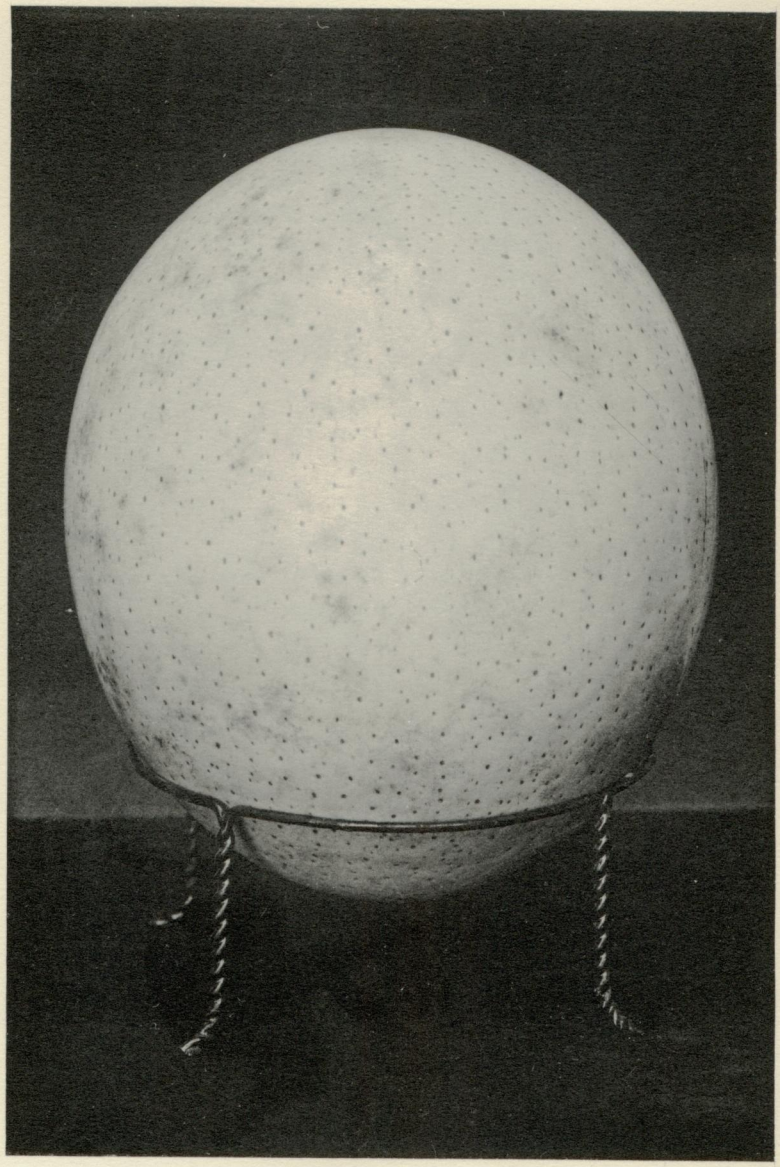


FIG. 5.
Chorus of a Comedy with Spear-men astride Ostriches. Painting on a Greek Vase.
After Daremberg and Saglio.



EGG OF DOMESTICATED OSTRICH FROM OSTRICH FARM IN CALIFORNIA (p. 5).
IN FIELD MUSEUM.

About two-thirds actual size.

Flinders Petrie (Naukratis, part 1, p. 14) recovered from the temple of Apollo at Naukratis a piece of an ostrich egg-shell with a pattern of wreath etched out of the inside, and the upper part stained red; the etching was probably done by drawing the wreath with wax on the shell and then eating out the background with vinegar; and the higher surface of the wreath was polished, like the rest of the inside, before etching.

Ostrich feathers were worn by men in ancient Egypt, being stuck in their hair, and a religious significance was possibly connected with this custom. Such feathers are invariably found in the hair of lightly-equipped soldiers of ancient times, and there is a hieroglyph showing a warrior thus adorned. An ostrich plume symbolized truth and justice, and was the emblem of the goddess Ma'at who personified these virtues, and who was the patron-saint of the judges. Her head is adorned with an ostrich feather, her eyes are closed, similarly as Justice is blindfolded. The image of this goddess was the most precious offering for the gods, and was attached to the necklace of the chief judge as a badge of office.

Subsequently when the insignia of the various ranks in the court ceremonial were regulated, the ostrich feather became the exclusive prerogative of the kings, and these and the princes of royal blood exclusively were permitted to wear it. Those decorated with the ostrich feather are designated as "fan-carriers on the left of the king" in the inscriptions of the monuments.

The princesses had fans made from ostrich feathers. In the tomb of the queen Aa Hotep, mother of Amasis I (about 1703 B.C.) was discovered a semi-circular fan decorated all over with gold plates and provided along its edge with perforations for receiving the feathers. When the Pharaoh showed himself to the people, high dignitaries carried ostrich-feather fans

attached to long poles alongside the royal palanquin.

Among the amulets of power conferred upon the dead were two ostrich plumes supposed to fly away in the wind, bearing the king's soul, and the pair of plumes therefore were provided as a vehicle for the soul of the deceased (Flinders Petrie, *Amulets*).

The British Museum has a terracotta from Nau-cratis representing a goddess on horseback with a lyre, wearing a head-dress surmounted by the solar disk, horns, and ostrich feathers (Walters, *Cat. of the Terracottas in the British Museum*, p. 256, with illustration).

In the eighteenth and first part of the nineteenth century the ostrich still lived in the plains of northern Egypt and along the Arabic coast of the Red Sea (Heuglin). Near the oases of middle Egypt it still occurs at present, likewise along the south-eastern frontier of the country.

THE OSTRICH IN THE TRADITIONS OF THE ANCIENTS

The ancients knew the bird as an inhabitant of northern Africa, upper Egypt, and Arabia.

The first Greek author who mentions the ostrich is Herodotus (IV, 175, 192). With reference to the Macæ who inhabited the coast of Libya, he states that they wore the skins of ostriches as a protection in war. He terms the ostrich "the bird remaining on the ground."

The skin of the ostrich is very thick, and still serves as a cuirass to Arabic tribes. Pierre Belon, a famous French naturalist of the sixteenth century, saw large numbers of ostrich skins with the feathers on in the shops of Alexandria, where they had arrived from Ethiopia. In northern Africa an ostrich skin is valued at about \$75.

Xenophon (Anabasis I, 5), when he accompanied the army of Cyrus through the desert along the Euphrates, in northern Arabia, noticed numerous wild asses and many ostriches which he calls "large sparrows," as well as bustards and antelopes; and these animals were sometimes hunted by the horsemen of the army. While they succeeded in catching some asses, no one succeeded in capturing an ostrich. The horsemen who hunted that bird soon desisted from the pursuit; for it far outstripped them in its flight, using its feet for running and raising its wings like a sail. This description is quite to the point. Macaulay said of John Dryden, "His imagination resembled the wings of an ostrich. It enabled him to run, though not to soar." The wings serve the ostrich, while running, as poy and rudder, and it has been observed that with favorable wind they are even used as sails. Xenophon confirms the fact that in ancient times the ostrich ranged right up to the Euphrates. The last record of ostriches in

the region of this river was in 1797 when Oliver mentioned them in the desert west of Rehaba, about twenty-three miles due south of Deir-ez-Zor.

Strabo (xvi, 4, 11), the Greek geographer (63 B.C.-A.D. 19), speaks of a tribe of Elephant-eaters near the city Darada in Ethiopia. Above this nation, he continues, is a small tribe, the Struthophagi ("Bird-eaters"), in whose territory there are birds of the size of a deer, which are unable to fly, but run with the swiftness of an ostrich. Some of the people hunt these birds with bows and arrows, others by putting on the skins of the birds. They hide their right arm in the neck of the skin and move the neck as the birds use to do. With their left hand they scatter grain from a bag suspended to the side. They thus lure the birds, driving them into ravines where they are slain with cudgels. Their skins are used both as clothes and as coverings for beds.

This method of hunting by means of a decoy-bird is perfectly credible and universally employed. In South Africa the native hunters hide in a hole which they dig close to the nest of the birds. Having accounted for one bird, they stick up its skin on a pole near the nest, and in this way decoy another ostrich. Other tribesmen who keep tame ostriches avail themselves of the latter to approach wild ones and shoot them with poisoned arrows.

George W. Stow (Native Races of South Africa) gives the following graphic account of the Bushmen's method of hunting (compare Plate V): "In stalking the quagga (*Equus quagga*), the Bushmen generally disguised themselves in skins of the ostrich, with a long pliant stick run through the neck to keep the head erect, and which also enabled them to give it its natural movement as they walked along. Most of them were very expert in imitating the actions of the living bird. When they sighted a herd of quaggas which they



BUSHMAN PAINTING IN A CAVE OF THE HERSCHEL DISTRICT, CAPE COLONY, SHOWING BUSHMAN
DISGUISED AS OSTRICH HUNTING OSTRICHES (p. 22).
After G. W. Stow.

wished to attack, they did not move directly toward them, but leisurely made a circuit about them, gradually approaching nearer and nearer. While doing so, the mock-bird would appear to feed and pick at the various bushes as it went along, or rub its head ever and anon upon its feathers, now standing to gaze, now moving stealthily toward the game, until at length the apparently friendly ostrich appeared, as was its wont in its natural state, to be feeding among them. Singling out his victim, the hunter let fly his fatal shaft, and immediately continued feeding; the wounded animal sprang forward for a short distance, the others made a few startled paces, but seeing nothing to alarm them, and only the apparently friendly ostrich quietly feeding, they also resumed their tranquillity, thus enabling the dexterous huntsman to mark a second head, if he felt so inclined. But as these primitive hunters never wantonly slaughtered for the mere sake of killing the game, like those who boast a higher degree of civilization, they generally rested satisfied with securing such a sufficiency as would afford a grand feast for themselves and their families, quite content with knowing that as long as the supply lasted, their feasting, dancing, and rejoicing would continue also."

According to Pliny, the feathers of the wings and tail were used as ornaments for the crests and helmets of warriors. The Athenian general Lamarchus wore two fine, white ostrich feathers on his helmet. The British Museum has a bronze statuette of Harpocrates wearing the Egyptian head-dress known as *atef*, resting on goat's horns; it is composed of three ostrich feathers, flanked by two *uraei* and surmounted by disks. Likewise a bronze statuette of Fortune has on her head a stephane surmounted by a disk, on each side of which is an ostrich plume, resting between a pair of wings (Walters, Catalogue of the Bronzes in the British Museum, Nos. 1494, 1540).

The ostrich was known to Aristotle as the bird who lays the largest number of eggs. He describes it as an animal which has the feathers in common with birds, but shares with the quadrupeds hairs, eyelashes, and the inability to fly; like the birds, it has two feet, but like many quadrupeds, cloven feet, and also resembles them in size; for this reason it has no toes, but claws, for a bird must be small in size, as it is not easy that a large bodily mass moves soaring in the air. Aristotle, accordingly, conceives the ostrich as a connecting link between birds and mammals.

In a similar manner Pliny opens his book on birds with a tolerably exact description of the ostrich which he terms *struthiocamelus* ("sparrow camel"), and which he calls the largest of birds almost approaching the nature of quadrupeds. He assigns it to Africa or Ethiopia and writes, "It exceeds in height a man sitting on horseback, and can surpass him in swiftness, as it is provided with wings to aid it in running. In other respects ostriches cannot be considered as birds, and do not rise from the ground. They have cloven talons, very similar to the hoof of a stag; with these they fight and also use them in seizing stones for the purpose of throwing them at their pursuers. They have the marvellous property of being able to digest every substance without distinction."

The ostrich stands about seven or eight feet high when full-grown, weighs upward of two hundred pounds, and in the wild state defies the horse and rider. At full speed it is said to make about twenty-six miles an hour. The family to which the ostrich proper, the rhea of South America, the emu of Australia, and the cassowary of the Malay Archipelago, South Pacific, and northern Australia belong, differs from other birds in having only small and rudimentary wings unadapted to flight, though they assist greatly in running; the barbs of the feathers are of equal length on each side of the

quill and of such a nature as to deprive the animal of the power of flight. The breast is rounded instead of being like a keel as in birds of flight. Aristotle and Pliny are right in attributing to it cloven feet; indeed, it has only two toes, the third and fourth in the pentadactyl system, but unequal in size and not covered with hoofs; the outer toe is much smaller and has no claw. The other members of the family have three toes.

The ostrich, as Pliny points out, is a good fighter. When wounded and hard pressed, it will attack a man, raise its leg to the height of his head, and kick him with its feet, which are hard like steel and yet elastic. A blow from this foot may rip open any animal on which it may fall. The notion that the bird hurls stones at its pursuers (according to Burton, prevailing throughout Arabia) may have been prompted by the observation that when it runs at great speed, it kicks up the stones behind with such violence that they would almost seem to be flung at the hunters in pursuit.

Although the ostrich will swallow almost anything, it is by no means able to digest everything, as Pliny thought. It demands stones instead of bread and swallows them in the same manner as other birds do gravel. They act as mill-stones and assist the gizzard in its function. In the South-African ostrich farms a certain amount of bone and grit is supplied to the birds. White quartz has been found to give excellent results. Grit is so essential that in some parts of the country it is carted by wagon or by rail for many miles, as it was found that without it the birds could not thrive—in fact, could not exist (Thornton).

The fondness for metals has obtained for the bird the name of the "iron-eating ostrich." In 1579 Lyly wrote in his *Euphues* that "the ostrich disgesteth harde yron to preserve his health." In Shakespeare's *Henry VI* Jack Cade thus threatens Iden: "I'll make thee eat

iron like an ostrich, and swallow my sword like a great pin, ere thou and I part."

The ancients entertained no high idea of the intelligence of ostriches. Pliny comments that their stupidity is remarkable; for, although their body is so large, they imagine that when they have thrust their heads into a bush, the whole of their body is concealed. Diodorus from Sicily, a Greek historian of the first century B.C., was much wiser in remarking that so far from displaying stupidity in thus acting, it adopts a prudent precaution, its head being its weakest part. The same author regarded the ostrich as a missing link between a bird and a camel. The ancient legend is still reflected in our phrases "ostrich policy" and "ostrichism."

In *The Birds* of Aristophanes (415 B.C.), the great Greek writer of comedy, the chorus sings thus:

To the bird of awful stature,
Mother of gods, mother of man;
Great Cybele! Nurse of nature!
Glorious ostrich, hear our cry!
Fearful and enormous creature,
Hugest of all things that fly,
Oh preserve and prosper us,
Thou mother of Cleocritus!

Nothing is known about Cleocritus, except that he was unfortunate in his figure, which was supposed to resemble that of an ostrich, while his mother had feet as large as those of an ostrich.

Cornelius Fido, a son-in-law of the poet Naso, is said to have burst into tears when Corbulo called him a bare-skinned or plucked ostrich (*struthocamelum depilatum*). Seneca who relates this anecdote thinks it funny that a man should lose his temper over so absurd a phrase.

The Arabs have a saying "more stupid than an ostrich," and the French use their *autruche* in the sense of a tall, idiotic fellow. The sweeping judgment of the ancients, however, is based on crude and limited

observation of the animal, and on erroneous interpretation of what they did not understand.

In his Report on Ostrich Farming in America Dr. T. C. Duncan (1888) writes that despite its proportionately small brain the bird is anything but stupid, as every one must own who has seen it breaking open the shell to let out a chick that is fast inside, or has seen it managing its chicks.

The Romans indulged in roast-ostrich, and especially enjoyed the wings as a delicacy. Paulus of Aegina, a celebrated physician of the seventh century A.D., writes that they are as juicy and savory as those of other birds. Caelius Apicius, a renowned gourmandizer at the time of Augustus and Tiberius, who committed suicide when he saw his fortune shrunk to two million and a half sesterii, has handed down several culinary recipes as to how to prepare good ostrich meat. The emperor Heliogabalus (A.D. 218-222) once served at a banquet six hundred ostrich heads, the brains of which were to be eaten, and was extremely fond of roast-ostrich. The usurper Firmus, who rebelled in Egypt against Aurelianus, performed the *tour de force* to do away with an entire ostrich in the course of a day. Ostrich fat was recommended by physicians as a remedy for all sorts of pain, and the stones found in its gizzard were believed to be a powerful medicine in eye diseases.

Toward the end of the Roman empire ostriches were sometimes shown in the arena of the circus. Three hundred birds are mentioned on one occasion, and a thousand on another as participants in a circus game. A Roman mosaic shows an ostrich acting in the amphitheatre. Eight ostrich teams figured in the triumphal procession of Ptolemy Philadelphus at Alexandria. The Roman emperor Firmus rode with an ostrich team and conveyed the impression as if he were flying. Amor is represented on an engraved gem as

being drawn by two ostriches (Fig. 6). A picture on a Greek vase illustrates a comical chorus of spearmen astride on ostriches (Fig. 5). A cut gem of Oriental, perhaps Gnostic origin, shows a running ostrich surrounded by symbolic designs, among these a star with apples (Fig. 7).

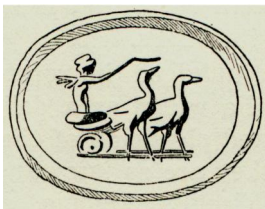


FIG. 6.

Amor with a Team of Two Ostriches. Cut Gem of Green Jasper.
After Imhoof-Blumer.



FIG. 7.

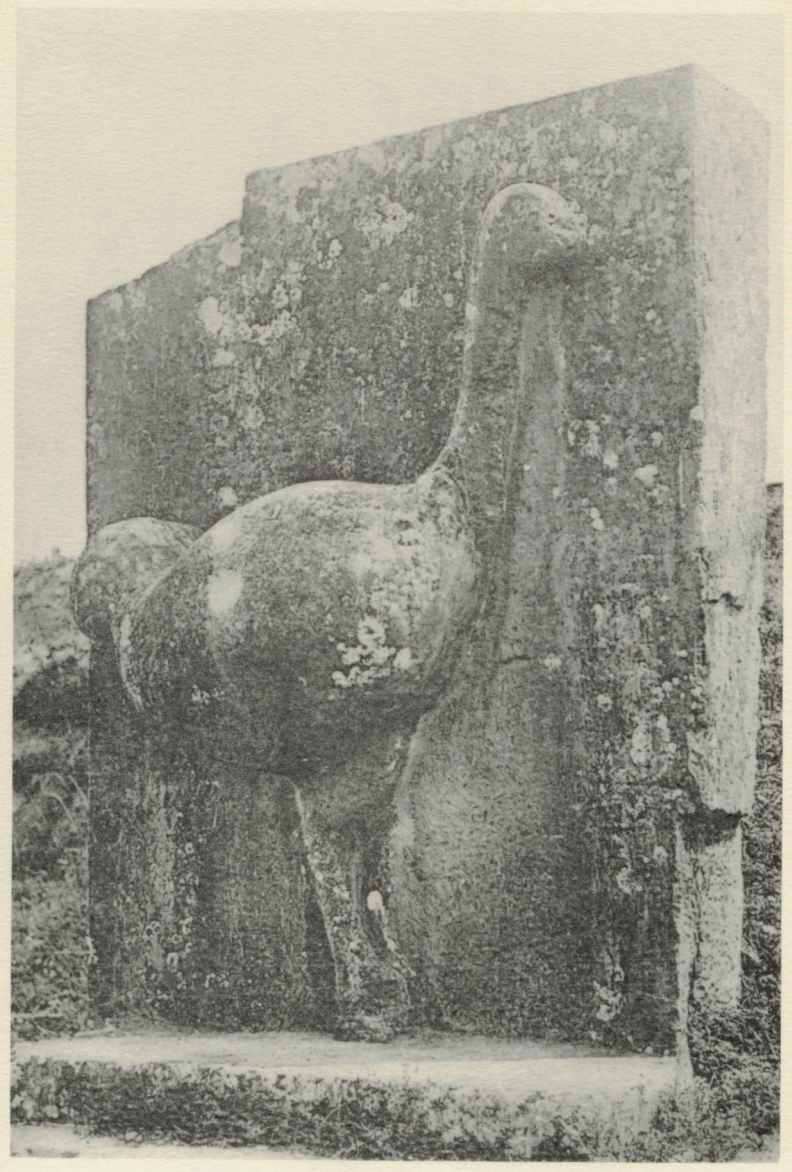
Cut Gem of Serpentine Representing a Running Ostrich, Surrounded by Symbolic Designs, among these Star with Apples. Oriental, perhaps Gnostic.
After Imhoof-Blumer.

THE OSTRICH IN THE RECORDS AND MONUMENTS OF THE CHINESE

The ostrich was first discovered for the Chinese by the renowned general Chang K'ien during his memorable mission to the nations of the west (138-126 B.C.). He returned to China with the report that in the countries west of Parthia there were "great birds with eggs of the size of a pottery jar." The "great bird" is the common name of the ostrich among all early Greek writers, while the name "camel-sparrow" or "camel-bird" is found at a later time in Diodorus and Strabo. When Chang K'ien had negotiated his treaties with the Iranian countries in the west, the king of Parthia (called Arsak by the Chinese after the ruling dynasty, the Arsacides) sent an embassy to the Chinese court, and offered as tribute eggs of the Great Bird. In A.D. 101 live specimens of ostriches, together with lions, were despatched from Parthia to China, and at that time were styled "Arsak (that is, Parthian) birds," also "great horse birds." On becoming acquainted with the Persia of the Sasanian dynasty, the Chinese Annals mention ostrich eggs as products of Persia, and describe the bird as being shaped like a camel, equipped with two wings, able to fly, but incapable of rising high, subsisting on grass and flesh, also able to swallow fire. Another account says quite correctly that the birds eat barley. When an attempt was made in Algeria to domesticate them, it was found that they thrive well on barley, fresh grass, cabbage, leaves of the cactus or Barbary leaves chopped fine; and three pounds of barley a day was recommended for each bird, green food according to circumstances.

To the north of Persia, the Annals of the Wei dynasty mention a country Fu-lu-ni, where there is a great river flowing southward; this territory harbors

a bird resembling a man, but also like a camel. Again, under the T'ang dynasty, in A.D. 650, the country To-khara offered to China "large birds seven feet in height, black in color, with feet resembling those of a camel, marching with outstretched wings and able to run three hundred (Chinese) miles a day and to swallow iron." They were then called "camel birds," in accordance with the Greek, Arabic, and Persian designations. Again, in the first part of the eighth century, ostrich eggs were sent to China from Sogdiana. We have to assume that the live birds transported from Persia to the capital of China over a route of several thousand miles must have been extraordinarily tame, and it was a remarkable feat at that. These birds must have been kept in the parks of the Chinese emperors who were always fond of strange animals and plants. What is still more astounding is the fact that in the mausolea of the T'ang emperors near Li-t'süan in Shen-si Province there are beautiful, naturalistic representations of ostriches carved in high relief in stone (Plates VI-VII and Fig. 8). The two sculptured slabs shown in the Plates were erected on the tomb of the emperor Kao Tsung, who died in A.D. 683; the one in Fig. 8 was placed on the tomb of the emperor Jui Tsung, who died in A.D. 712. The artists of the period doubtless received an imperial command to portray the ostriches of the imperial park in commemoration of the vast expansion of the empire over Central Asia during that epoch. As shown by their results, they did not copy any foreign artistic models, but they witnessed and carefully observed and studied live specimens. Their ostriches, in fact, belong to the best ever executed and known in the history of art, and are far superior to any representations of the bird in Assyria, Egypt, and Greece, which are conventional and stiff. The Chinese ostriches are correct in their accentuation of motion and action. The formation and length of the neck allow the bird



CHINESE STONE SCULPTURE OF OSTRICH ON THE TOMB OF THE EMPEROR KAO
TSUNG (p. 30). T'ANG PERIOD, SEVENTH CENTURY A.D.

After E. Chavannes.

to turn its head completely around, a characteristic skilfully brought to life in stone by the unknown Chinese sculptor (Fig. 8).

For comparison the sketch of an ostrich by Albrecht Dürer is reproduced in Plate VIII. It is dated 1508 with the addition of the monogram A. D. It is supposed that during his stay in Venice the artist may

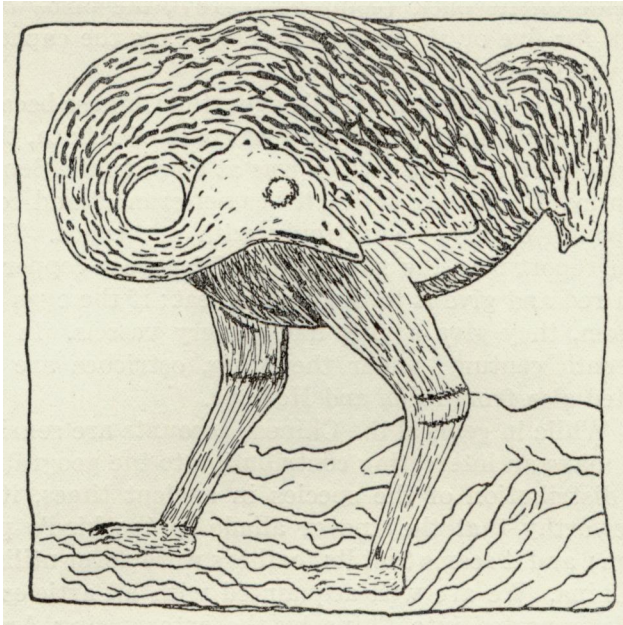


FIG. 8.

Chinese Stone Sculpture of Ostrich from the Tomb of the Emperor Jui Tsung.
T'ang Period, Eighth Century.
After E. Chavannes.

have had occasion to view a live ostrich. His sketch is better than that of his contemporary, the naturalist C. Gesner, who had evidently never seen the bird. In the museum of Nuremberg there is a painting of Wohlgemut representing the adoration of the Three Magi; the Moor offers an ostrich egg filled with spices and bordered with gold or silver. The initials A.D. on the

egg possibly refer to Dürer, and may hint at his collaboration.

Under the T'ang, the Chinese were also informed of the fact that the ostrich was a native of Arabia. It is on record that "the camel-bird who inhabits Arabia is four feet and more in height, its feet resembling those of a camel; its neck is very strong, and men are able to ride on its back (compare p. 16); the birds thus walk for five or six miles. Its eggs have the capacity of two pints."

When, during the middle ages, the Chinese became slightly acquainted with the east coast of Africa, they learned also that the ostrich was at home in the Somali country. Then they styled it "camel crane," and compared its eggs not unfittingly with a coconut. They even report that the natives of Africa heat copper or iron red and give it to the birds to eat; if the eggs are broken, they give a ring like pottery vessels. In the fifteenth century, under the Ming, ostriches are reported also from Aden and Hormuz.

While in general the Chinese accounts are sensible and make an interesting contribution to the geographical distribution of the species in ancient times, it is noteworthy that they never allude to the bird's plumage; and it seems that its feathers were never utilized in China. We are well acquainted with all articles of trade imported into China by the enterprising Arabs from the early middle ages down to more recent times, but ostrich plumes are never mentioned. Feathers of pheasants were used by the Chinese for the decoration of head-dresses, peacock and eagle feathers for fans, the blue feather of the kingfisher for inlaying in ornaments and screens.

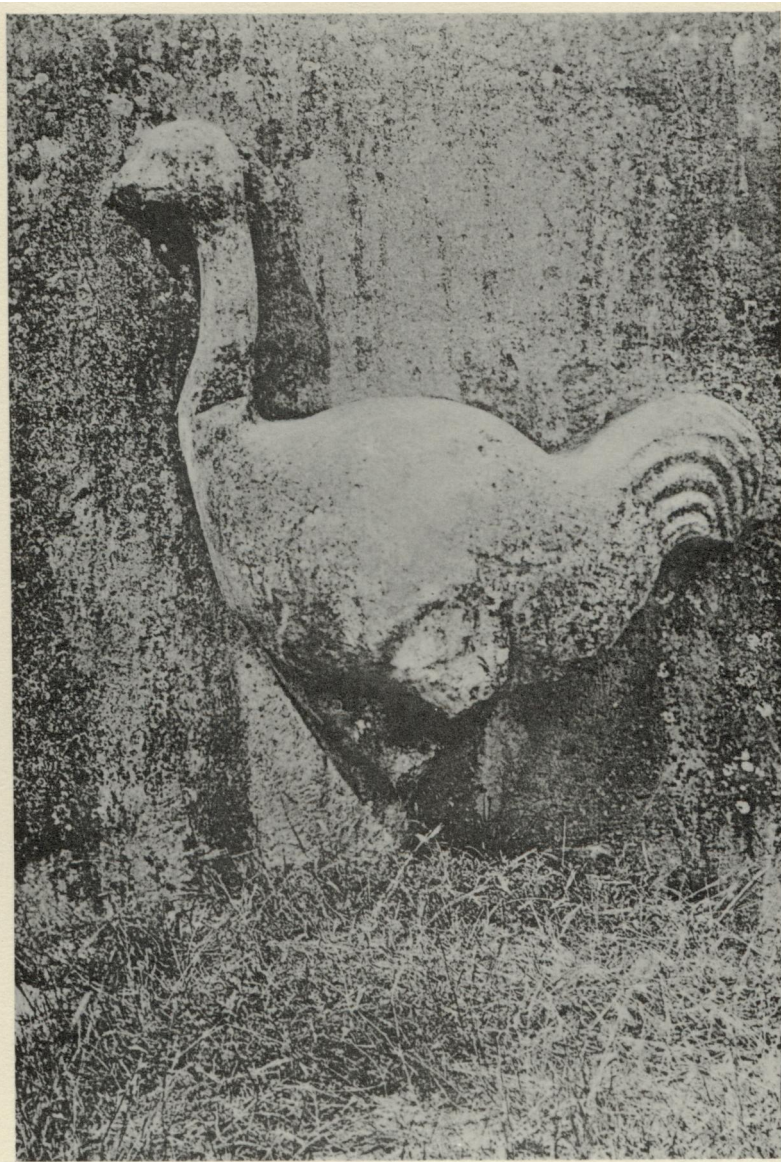
The area of the habitat of the ostrich was formerly much more extended than at present; continued persecution of the bird for the sake of its precious plumage has exterminated it in certain districts or decreased its

numbers. It may still occur in some parts of southern Persia, and still lingers in the wastes of Kirwan in eastern Persia, whence individuals may occasionally stray northward to those of Turkestan, even as far as the lower course of the Oxus. No representation of the bird has as yet been found in Persian art.

THE OSTRICH IN AFRICA

The ostrich has reached its greatest extension in the vast grass steppes of Africa, especially those covered with brushwood, where it finds the best conditions for living and satisfying its nomadic habits. There it migrates from pasture to pasture, and may appear and disappear in a certain locality, particularly when forced by lack of food or droughts to move. A gregarious animal, it wanders about in flocks of twenty and thirty and keeps strictly to the steppe, but avoids altogether forests, high tablelands, and damp and swampy tracts. It associates also with other species, like giraffes, zebras, and antelopes (Plate IX), who look upon the ostrich as their guardian. On account of its tallness and far-sightedness the bird is the first to give them a danger signal. The ostrich is extraordinarily keen-sighted, and on its native plains is extremely wary. The whole tribe is characterized by excessive shyness and timidity without which in the struggle for self-preservation it would ere this have ceased to exist.

The ostrich lives on cereals, seeds of grasses, vegetables, leaves, buds, berries, dates, fruits of the tamarind and palms, young birds, lizards, beetles, grasshoppers, etc. In general frugal and capable of withstanding hunger and thirst for days, it becomes greedy and indiscriminately voracious at times. The birds perform strange dances in the sunshine, run around in a circle, flap their wings, and endeavor to rise into the air. During the mating season the male always woos the female with wild and eccentric dances. He is the original inventor of the Charleston. Ostriches are fond of bathing and swimming, and have been observed to take to the brine. In more than one respect they are almost human, and in their mobility and peregrinations



CHINESE STONE SCULPTURE OF OSTRICH ON THE TOMB OF THE EMPEROR KAO
TSUNG (p. 30). T'ANG PERIOD, SEVENTH CENTURY A.D.

After E. Chavannes.

over vast stretches of land they are typical, restless nomads given to a life of hustle and bustle.

The natives of Africa have at all times appreciated both its feathers and flesh. The former are used as fly-whisks and as ornaments on lances, in the kingdom of Congo as war standards, by the Somali as head-ornaments. The empty egg-shells serve as water-vessels, and are suspended in tents and mosques. The roofs of straw huts in the Sudan are adorned with the eggs. Many Negro tribes cut the shell into small button-like



FIG. 9.

Painted Ostrich Egg from Etruscan Tomb of Isis.
After G. Dennis.

pieces which they perforate and string, wearing such strands as necklaces. Perforated and decorated ostrich egg-shells, together with implements of the stone age, were unearthed by Foureau in the Sahara.

Painted ostrich eggs were discovered in the Punic tombs of Carthage and even in the tomb of the valley of Betis in Spain. In the tomb of Isis opened at Vulci, Italy, in 1839, and so called on account of the Egyptian articles found in it, but in fact the sepulchre of two Etruscan ladies of rank, were found six ostrich eggs, one of these being painted with a winged camel or, more

probably, a fabulous creature (Fig. 9). G. Dennis (Cities and Cemeteries of Etruria) is inclined to think that these eggs were imported from Egypt, but others assume that they testify to the ancient commercial relations between Etruria and Carthage. There is a fragmentary cup of plated silver, presumably imported from Carthage into Etruria, which is adorned with rows of fantastic and real animals, among these unmistakable ostriches.

The trans-Saharan trade in ostrich eggs has persisted to the present day. The eggs are sent along with the consignment of feathers and emerge at the towns of the Mediterranean coasts of Tunis and Tripolis, where they are in request as pendant ornaments in the mosques.

Richard F. Burton (Lake Regions of Central Africa) wrote in 1860, "The ostrich extends through Unyamwezi and Usukuma to Ujiji. The eggs are sold, sometimes fresh, but more generally stale. Emptied and dried, they form the principal circulating-medium between the Arab merchants and the coffee-growing races near the Nyanza Lake, who cut them up and grind them into ornamental disks and crescents. The young birds are caught, but are rarely tamed. In Usukuma the bright and glossy feathers of the old male are much esteemed for adorning the hair; yet, curious to say, the bird is seldom hunted. Moreover, these East Africans have never attempted to export the feathers, which, when white and uninjured, are sold, even by the Somal, for eight dollars a pound. The birds are at once wild and stupid, timid, and headstrong; their lengthened strides and backward glances announce terror at the sight of man, and it is impossible to stalk them in the open grounds, which they prefer."

The Nandi in eastern equatorial Africa wear a cockade of ostrich feather in times of war. It is with them also an emblem of peace; when after war peace is

desired, an ostrich feather is placed in a high-road in a prominent position. The Nandi have the following riddle: "What is the thing which, though so weak that it is blown about by the wind, is able to herd oxen?" Answer: "The ostrich-feather head-dress." The grass in the Nandi country is so high that only a warrior's head-dress can be seen above it, and at first sight it often appears as if a herd of oxen were being guarded by the ostrich feathers, which are the plaything of every gust of wind (A. C. Hollis).

Among the Somalis the ostrich feather is universally used as a sign and symbol of victory. Every man hangs to his saddle-bow an ostrich feather, and generally the white feather only is stuck in the hair. All the clans wear it in the back hair, but each has its own rules. Some make it a standard decoration, others discard it after the first few days. The learned have an aversion to the custom, stigmatizing it as pagan and idolatrous; the vulgar look upon it as the highest mark of honor (R. F. Burton).

In the Lango country the white ostrich feathers are dyed red with iron ochre and worn as head-ornaments. The greater part of the feathers now exported from the Sudan are furnished by ostriches taken young and reared by the Shilluks and Bagaras. These birds become as tame as chickens; in the morning they go to the fields with the cattle, and return home in the evening.

The ostrich-hunters par excellence were the Bushmen of South Africa, now extinct. Their legends prove that they had an intimate knowledge of the life of the ostrich. Two of these are recorded in the "Specimens of Bushman Folklore" by Bleek and Lloyd (1911). One of these, entitled the Resurrection of the Ostrich, gives a good picture of the bird's mating habits and winds up thus: "He will drive away the jackal, when he thinks that the jackal is coming to the eggs, the jackal will

push the eggs. Therefore he takes care of the eggs, because they are indeed his children. Therefore, he also takes care of them, that he may drive away the jackal, that the jackal may not kill his children, that he may kick the jackal with his feet."

Fig. 10 represents two sketches of ostriches made by the Bushmen living in the west corner of the Orange

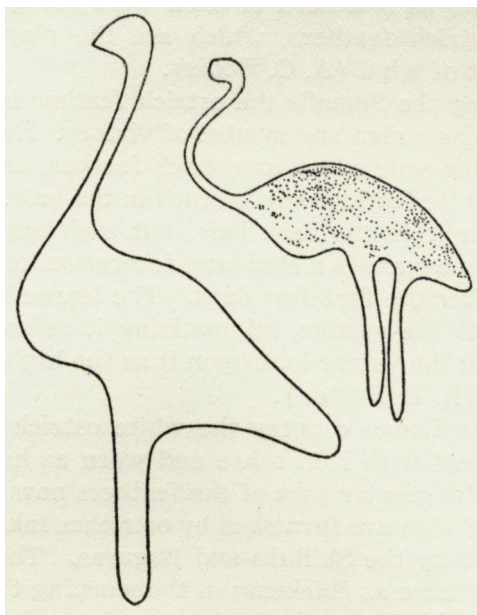


FIG. 10.

Bushmen Rock Carvings of Ostriches.
After M. Helen Tongue.

River Colony. They are reproduced from the work of M. Helen Tongue, "Bushman Paintings" (Oxford, 1909). These pictures are carved in rocks by means of a stone. The markings indicating feathers in the sketch on the right are chipped in the scraped-out surface of the flat stone. The curved neck and the outline of the body testify to good observation. The other sketch is more primitive and not so good. A fine example of

Bushman paintings of ostriches is reproduced in Plate V.

In excavating the diamond-bearing deposits at Du Toit's Pan, in Griqualand West, numerous Bushman beads made of ostrich egg-shell were found at various depths ranging from six to eight feet, and in several spots resting on the bed of calcareous tufa. These local accumulations had evidently been very gradual in their formation. Multitudes of minute land-shells were interspersed throughout them, the animals which inhabited them having evidently perished and been entombed while traversing the arid sand. This place had obviously been a great station for the Bushmen, in the midst of the ostrich country, and had in all probability been a locality, where the manufacture of ostrich egg-shell beads had been carried on for generations. Some were found in various stages of manufacture. Some of those dug out from the lowest depths had become perfectly fossilized, and adhered to the tongue.

A belt from three to six or seven inches in width, formerly worn by young Bushman women, consisted of small circular pieces of ostrich egg-shell bored in the centre and strung like buttons with their flat sides together. Necklaces were made in a similar manner. After the stronger peoples came in contact with the Bushmen bead-makers, they used to purchase these pierced disks of egg-shell from the latter for small bits of iron. Ostrich egg-shells also furnished the Bushmen with water-bottles in which to carry water to the place of their haunt. The openings were closed with a bunch of grass. The women carried twenty or thirty of such egg-shells in a bag or net on their backs.

Spears and poles dressed with black ostrich feathers were stuck in the ground around places, where the Bushmen halted during their hunting expeditions, in order to frighten away lions, which, from their experience, it was discovered were not fond of their ap-

pearance (G. W. Stow, Native Races of South Africa).

The Bushmen, further, used the breastbone of the ostrich as a dish, made threads of its sinews and wrought these into nets and bags.

From the remains of ostrich egg-shells is prepared a powder which is also regarded by the Boers as an excellent remedy for man and cattle; it is even said to protect one from blindness.

In South Africa the ostrich exists now only in the domesticated state. In the Kalahari desert, however, in the tablelands of South-west Africa, Matabele and northern Rhodesia it still occurs wild.

THE DOMESTICATION OF THE OSTRICH

The ostrich is the most recent of all domesticated animals, and its complete domestication was accomplished by the white farmers of South Africa as late as the latter part of the nineteenth century. It is the only domestication that occurred in modern times, and the only one to which, with certain reservations, our own civilization may lay claim; all other domestications of large mammals and birds were brought about ages ago, either in Asia or Africa, and were simply adopted by the nations of Europe. The first step toward domestication is taming and training, but a tamed animal is not necessarily domesticated. In India, for instance, the elephant has been tamed and schooled as a laborer to a high degree of perfection, but does not propagate in captivity; for this reason it is not classed among domesticated animals. In the stage of domestication the animal propagates its species, and in its breeding is to a great extent influenced by human interference; it will gradually lose many of its savage instincts and acquire new useful qualities. In this manner are formed numerous new varieties which exhibit many differences from the original type and greatly vary in size, color, habits, even in anatomical and mental traits.

Long before the advent of the white man, the natives of Africa had kept ostriches in captivity and tamed them to a certain extent, but they did not succeed in domesticating them. A few examples may suffice to illustrate this point.

In the Uganda Protectorate, where the ostrich is a native of the northern and eastern districts, its eggs and recently hatched young are constantly brought in by the natives for sale. Boyd Alexander (From the Niger to the Nile) writes that in Bornu the ostrich is not much

hunted, because it is very difficult to get near, but that the natives catch the young which become domesticated, most of the big men in Bornu owning three or four. The word "domesticated" is here used in a loose fashion, not in the strictly scientific sense.

For generations the Arabs and Berbers of North Africa have kept the ostrich in small kraals and ruthlessly plucked its feathers. These are birds captured as chicks from the nest of the wild bird, but chicks were never bred in captivity.

In Kordofan in the Egyptian Sudan young ostriches are frequently reared, fattened, and slaughtered; the flesh is eaten either fresh or dried. In the Arabic villages of Central Africa ostriches are kept for their feathers; they are hatched from eggs accidentally discovered. In the Sudan chicks are caught, raised by hand and kept until the birds become too old to produce feathers of paying quality, when they are killed and eaten. The system of farming these birds is to enclose each in a small circular mud wall or enclosure, about eight feet in diameter. The birds are never given an opportunity to breed; and this practice, being continued for centuries, has led to the belief that the ostrich will not breed in captivity. The method of removing the feathers from these captive birds was atrocious and the crudest possible; whenever the native farmer required money, he pulled as many feathers from the bird as he could remove in order to turn them into cash. The stage of the growth of the feathers was not considered, the feather sockets were damaged, and in the course of two or three years the birds produced only worthless feathers. It was a system of spoliation inspired by the most sordid greed of profit.

In the eighteenth century ostriches were still plentiful in southern Africa. Peter Kolbe, who spent ten years there on scientific research, wrote in 1742, "These birds occur in the Cape Territory in so large a number



SKETCH OF OSTRICH BY ALBRECHT DÜRER, DATED 1508 (p. 31).
After S. Killermann.

that you cannot travel for a quarter of a mile without seeing some of them. They can easily be tamed, and many are kept in the Citadel of the Cape."

As early as 1662, Jan van Riebeeck, Dutch commander of the Cape Colony (1652-62), directed his successor's attention to the taming of young ostriches. On several occasions tame ostriches had been sent to the Indies, where they had proved acceptable presents to native potentates. Their feathers were saleable, but it does not seem to have occurred to any one in those days that it would pay to tame the bird for the sake of its plumage (G. M. Theal, *History of Africa South of the Zambesi*).

When in 1865 the domestication was first attempted in South Africa, natives who had some experience in managing the birds were employed as trainers; but when it has been recognized that the domestication is historically connected with the crude efforts of the natives, it must be frankly admitted, on the other hand, that the success of the actual domestication is solely to the merit of the Afrianders. They certainly availed themselves, as it could not be expected otherwise, of some of the experiences previously accumulated for many centuries, not as mere imitators, however, but as novel investigators who grasped the situation with open eyes and energetically applied themselves to a minute study of the bird's life-habits. By creating for their favorite its natural surroundings, by reserving to it vast spaces for movement and exercise, and by proper feeding and care-taking, above all, by sympathy and understanding, their success was permanently insured. Just because these simple farmers were simply human and humane, they achieved what was denied to the Egyptians, Romans, or Arabs with their vain conceit. The barbarous treatment which the poor bird had hitherto received from the hands of African savages

gave way to a charitable attitude and an enlightened method prompted by truly scientific research.

The domesticated stocks of South Africa were produced from captured wild chicks who, on reaching the age of maturity, were allowed to breed. Due to careful handling and selected breeding, the quality of the feathers has vastly improved.

The following figures may illustrate the rapid progress made by the industry in South Africa since ostriches were first domesticated. In 1865 there were in South Africa 80 domesticated ostriches; the weight of feathers exported in that year was 17,000 lbs., most of which were feathers of wild birds, valued at £65,000. Ten years later, in 1875, there were 32,000 domesticated birds, and the export of feathers amounted to 100,000 lbs., to the value of £300,000. In 1891 the number of domesticated birds had increased to 154,000; weight of feathers exported was 212,000 lbs., probably including a small amount of wild birds' feathers, to the value of £563,000. In 1904 there were 307,000 domesticated ostriches; the export of feathers was 470,000 lbs., valued at £1,058,000. In 1908 a maximum of 700,000 domesticated ostriches was reached; the weight in feathers exported came to 800,000 lbs., valued at £2,098,000. In 1913 a million pounds of feathers were exported, valued at £2,750,000. There is, accordingly, the remarkable result that during a period of forty-eight years the industry has risen from an export value of £65,000 to £2,750,000; that is, an increase of 4130 per cent.

In mediæval Europe ostrich plumes decked the helmets of knights, later the hats of cavaliers, and the fashion came in again for a time at the Restoration. The fashion of the seventeenth century was dominated by a large felt hat decorated with ostrich plumes laid around the brim. Their natural beauty, particularly

the graceful curve taken toward the tip, has always had a strange fascination for the human heart.

The feathers are now utilized for the decoration of ladies' hats, as well as for the making of fans and boas. For the latter the flue or soft portion of the feathers only, also damaged and inferior feathers, are used. The flue of inferior feathers serves also for padding clothes and quilts. The market, of course, is subject to fluctuations due to changes of fashion, but it is very unlikely that the demand for ostrich feathers will ever completely die out.

Each bird has twenty-five white plumes in each wing with a row of protectors, floss feathers underneath. Above these are a row of black feathers and still another row of shorter ones which are black in the adult male and drab in the hen. The feathers are removed by clipping; at the age of six months the birds receive their first clipping, and thereafter are clipped at intervals of nine months. The bird will continue to produce good feathers for practically an indefinite period. This method is perfectly humane, the bird does not receive any injury whatever. Feeding was found to have a very marked effect on the feather growth. This led to the pampering of the bird to such an extent that it is now fed on everything it desires. This method of humorizing its appetite has produced the best results. The fact that the highly-fed ostrich gave the greatest financial return was the cause of erecting the majority of the largest irrigation-works undertaken in South Africa. The return was so enormous that many irrigation-works which could not have been undertaken otherwise were carried out as paying propositions, and are at present a source of immense wealth to the country.

The farmer of South Africa, as R. W. Thornton justly says, is under an inestimable debt of gratitude to the ostrich as being the means by which the best areas of arid land have been converted under irrigation into

highly productive fodder-producing areas, which, even if the industry were to fail, would be of incalculable value as fodder-producing areas for any class of farming.

Experiments to introduce ostrich domestication into Algeria in 1881 were unsuccessful. Egypt has an ostrich farm near Matarieh north of Cairo.

In view of the similar climatic and soil conditions of South Africa and Australia and considering the fact that the camel introduced in 1846 was rapidly acclimatized in Australia, it was suggested to naturalize there also the South African ostrich. Its breeding was started in 1880 in the southern part of the continent, but has thus far not been very successful. The statistics of the Australian Government for the year 1922 give the number of ostriches in the Commonwealth as 780, which is a small figure as compared, for instance, with 11,738 camels. Good results were attained on an ostrich farm near Christchurch in New Zealand. Near Buenos Ayres, in Montevideo, Argentina, and Patagonia ostrich farms were also founded.



WILD AFRICAN OSTRICHES WITH EGGS AND CHICKS, IN ASSOCIATION WITH ZEBRAS AND ANTELOPES (p. 34).
After O. Schmeil.

THE OSTRICH IN AMERICA

In 1882 Dr. Charles J. Sketchly, one of the greatest ostrich-farmers in South Africa, transported a troop of two hundred picked ostriches from Cape Town via Buenos Ayres to New York. From there the birds were forwarded by railroad via Chicago and Omaha to the Pacific coast, having covered a distance of 23,000 miles. Twenty-two arrived in California in fair condition, and were at once taken to Anaheim. The California Ostrich Company was soon formed with a capital of \$30,000, and Dr. Sketchly was made superintendent. The first year these birds resided in America they presented the company from April to October with 270 eggs.

At the same time the American Ostrich Company was organized in Maine with E. J. Johnson as manager. He went to Africa and spent there a year, studying the habits and management of the birds. He started with twenty-three of them and landed at New Orleans in December, 1884, after a voyage of fifty-three days, with all the birds alive,—a remarkable result, as the usual loss at sea is about 25 per cent. He settled in the valley of the San Luis Rey, about seven miles from the town of Fallbrook, north of San Diego, in southern California. The clear, dry air, the excellent water, and the shelter afforded by the Santa Rosa hills furnished suitable conditions for the establishment of an ostrich farm. The birds took kindly to their adopted home, and have thriven well, the old ones maintaining their natural vigor, and the American-born being at two years unusually fine, both in size and quality of feathers. The breeding birds are kept paired in corrals of an acre in extent. Those one and two years old are left a range of some thirty acres on the mesa, while the young chicks are allowed to run with the other barnyard fowls. The

ostrich is now perfectly acclimatized in this country, and it is even asserted that the American birds are finer and larger than their African progenitors.

Other farms soon followed, and are now established near Los Angeles, San Diego, and San José, California; Hot Springs, Arkansas; Jacksonville, Florida; Phoenix, Arizona, also in Oklahoma and Texas. Ostrich farming has developed into an industry of great importance.

The scientist is gratified at the domestication of the ostrich, because it supplies the demands of the feather trade and will therefore lessen or ultimately stop the reckless slaughter of wild ostriches and, let us hope, also the killing of song-birds formerly sought for their feathers. It will enable us, further, to obtain an accurate account of the bird's life history and habits and to render it justice and correct the numerous errors to which the ill-founded fables of past centuries have subjected it. Until recent times it was believed, for instance, that the ostrich is polygamous and mates with from two to five or more females. A. Reichenow (1900) is the first who observed that the wild cock pairs only with a single hen, and I am inclined to assume that he is right; for it has been found that the birds reared in captivity are monogamous, and it can hardly be supposed that the ostrich, perhaps under the influence of American environment, should have suddenly repented and changed from harem habits to a state of monogamy. Some years ago F. J. Haskin, after studying an ostrich farm near Los Angeles, reported, "The ostrich is abnormally finicky about mating. Some birds remain determined bachelors all their lives, and every one chooses his mate only with great delay and caution. Usually it takes two or three years of earnest and patient courtship on the part of the hen before she ensnares her prey. But once captured, the male ostrich is her devoted slave for life. He flutters anxiously

about her while she sits on the family eggs and takes up an unnecessarily combatant attitude, one deadly toe-nail raised for fight, whenever another bird or the keeper ventures within ten feet of her. If she dies, moreover, he remains a melancholy widower to the end of his days. When one of the males was widowed as a result of his wife getting her head caught in the fence, the keeper picked out the finest female in the flock and offered her as a substitute. She was in the pen just three seconds when the keeper had to risk his life to get her out. As it was, she received such a hard kick that she nearly died and had to be removed to the hospital pen. The hen has no such scruples when it comes to remarrying, and is polite, if not enthusiastic, to every suitor introduced to her. Once in a long while, also, a male bird is found who is not so sternly monogamous. There is one of this type at the farm who has condescended to espouse two wives. They call him 'Brigham Young'."

Captivity has brought about a remarkable change in the attitude of the old birds toward their young. Whereas in the wild state they are good and tender parents, they apparently do not recognize the young bred at the farms under the incubator system. They cherish no affection for their offspring which has thus not been hatched or raised by them, and their impulse usually is to kill the young on sight. What is said in the book of Job about the ostrich's want of regard for its young now sounds like a true prophecy. Pliny, however, if he could come back to life and would visit one of our ostrich farms, would doubtless offer an apology for his somewhat hasty verdict. Civilization, after all, advances: from a mercilessly persecuted and tormented creature we have transformed the ostrich into a happy and contented bird and an eminently useful denizen of our soil. The domestication of the ostrich is a positive contribution to the progress of humanity and

humaneness, and may be designated one of the great achievements of modern civilization of which the Africander may justly be proud and for which we have every reason to be grateful to him.

B. LAUFER.

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The Prehistory of Television

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It is hardly necessary to expatiate on these data. They are self-explanatory, and any attempt to adorn them would be presumptuous. I can not resist suggesting, however, that in view

of this evidence of early biological wisdom we should look carefully to our laurels in order to be sure that they are not indurated with the dust of the ages.

THE PREHISTORY OF TELEVISION

By Dr. BERTHOLD LAUFER

CURATOR OF ANTHROPOLOGY, FIELD MUSEUM OF NATURAL HISTORY, CHICAGO

IN his drama "Back to Methuselah" George Bernard Shaw depicts the following scene as a reality in the year 2170: the head of the British government is holding a conference with his cabinet ministers, who are several hundred miles distant, in this manner—that he operates a switchboard near his desk and, by pressing a certain key, makes appear on a silver screen a life-size picture of the person to whom he desires to talk and whose voice is simultaneously transmitted.

In April, 1927, the Bell Telephone Laboratories gave the first practical demonstration of transmitting over electric wires the pictures and voices of moving persons, voice and image being perfectly synchronized. A two-way telephonic communication was maintained between Washington and New York. Secretary Hoover in Washington opened the demonstration, and the illuminated image of himself cast over the wire on a screen in New York synchronized perfectly with his voice that was heard over the telephone at the same time. One telephone line was used for transmitting the voice, another for transmitting the television current and a third for synchronizing the electric driving-motors at each end of the lines. It has since been demonstrated that both the voice and the "picture" currents can be sent over the same wire or, in the case of radio transmission, over the same wave-length.

While television at present is a fact, it has been the dream of mankind for hundreds and thousands of years. In my monograph, "The Prehistory of Aviation," recently published by Field Museum, Chicago, I have emphasized the fact that human imagination has been of paramount importance and proved most fertile in the development of mechanics and inventions and that the trend of man's mind toward the romantic and adventurous has resulted in the conquest of the air. The essential point is that many fundamental contrivances have not been reasoned out logically through progressive scientific thought, but that man's mind conceived them through visionary reveries as an accomplished fact and then proceeded to work toward this imaginary goal. Thus television also has its prehistory in the domain of oriental folk-lore, a brief outline of which is given on the following pages.

In Firdausi's great epic poem, the *Shāhnāmeh* ("Book of Kings"), figures a cup which mirrors the world and distant persons. It is the property of King Kai Khosrau and appears in the love-story of Bizhan and Manizha. The king, while holding a feast, receives a petition for succor from the people of Irmān, whose country is being ravaged by wild boars, and sends Bizhan and Gurgin to scour the country of them. Through the machinations of Gurgin, who envies him, Bizhan falls in love with Afrasiyab's

daughter, Manizha, who carries Bizhan off to Turan and hides him in her palace. He is discovered and imprisoned in a pit with Manizha as his attendant. In the meantime Gurgin has returned to Iran, where his lame story rouses suspicion. By means of the divining-cup Kai Khosrau ascertains Bizhan's situation and dispatches the hero Rustam to deliver him. The king says to Giv, Bizhan's afflicted father (in Warner's translation):

Then will I

Call for the cup that mirroreth the world,
And stand before God's presence. In that cup
I shall behold the seven climes of earth,
Both field and fell and all the provinces,
Will offer reverence to mine ancestors,
My chosen, gracious lords, and thou shalt know
Where thy son is. The cup will show me all.

Then the poet narrates how Kai Khosrau saw Bizhan in the cup that shows the world:

When jocund New Year's Day arrived, Giv
yearned

For consultation with that glorious cup,
And came, bent double on his son's account
But hopeful, to Khosrau who, seeing him
With shrunk cheeks and sorely stricken heart,
Went and arrayed himself in Ruman garb
To seek God's presence. Then before the
Maker

He cried and oft-times blessed the Shining One,
Imploring of the Succorer succor, strength,
And justice on pernicious Ahriman,
And then returning to his throne, assumed
The Kaian crown, took up the cup, and gazed.
He saw the seven climes reflected there,
And every act and presage of high heaven,
Their fashion, cast, and scope, made manifest.
From Aries to Pisces he beheld
All mirrored in it—Saturn, Jupiter,
Mars, Leo, Sol and Luna, Mercurey,
And Venus. In that cup the wizard-king
Was wont to see futurity. He scanned
The seven climes for traces of Bizhan,
And, when he reached the Kargasars, beheld
him

By God's decree fast fettered in the pit,
And praying in his misery for death,
With one, the daughter of a royal race,
Attending him. The Shah, with smiles that
lighted

The daïs, turned his face to Giv and said,—
"Bizhan is yet alive; be of good cheer!"

In one of the stories of the Arabian Nights (No. 271) the three sons of a Sultan of India—Prince Husain, Prince Ali and Prince Ahmed—undertake a year's journey into a distant part of the world to find some unusual treasure for their royal father, who had promised the hand of a princess to him who would bring back the rarest jewel. Prince Ali traveled to Shiras, capital of Iran, and while rambling in the bazar of the city, one day met a man who carried in his hand an ivory tube about a yard long and offered it for sale at the price of thirty thousand sequins. The prince thought him to be a fool, as he demanded so enormous a sum for such a wretched thing, but was soon informed that this broker was wiser and more sensible than all others of his profession. He examined the ivory telescope, which was equipped with a piece of glass at either end and which if placed in front of the eye brought anything close to it, even though it may have been many hundreds of miles away. Moreover, this tube had the miraculous power of showing any object or any person its owner desired to see. Prince Ali wished to see his father whom he had left in India, and no sooner did he hold the ivory tube close to his eye than he espied him hale and hearty seated on his throne and giving judgment to the people of his land. Then he demanded to behold his beloved princess, and immediately he caught sight of her as she was leisurely reclining on a couch, chatting and laughing and attended by a flock of maids.

In Grimm's tale, "The Four Skilful Brothers," the situation is very similar to that of the preceding story. Four brothers go out into the world to earn their living and to learn a craft. One becomes an expert thief. The second meets a man who asks him what he wishes to learn in the world. "I do not know it yet," he replies. "Come along with me and become a star-gazer; there

is nothing better than that, nothing will be hidden to one." He consented and became so clever a star-gazer that his master, when the boy had finished his apprenticeship and would leave him, presented him with a telescope and said, "This will enable you to see what occurs on earth and in heaven, and nothing will remain concealed to you." He meets with his three brothers, who have also acquired an extraordinary art, and soon there is an opportunity for them to put their knowledge to the test. The king's daughter was kidnapped by a dragon, and the king made it known that he who would bring her back should receive her as his consort. The four brothers decide to deliver her from the dragon. "I shall soon know where she is," said the star-gazer, looked through his telescope and announced, "I behold her, she is seated far away on a rock in the sea and beside her the dragon who guards her." Then he went to see the king and requested a ship for himself and his brothers, and crossed with them the sea till they arrived at the rock. They return with the king's daughter, and naturally engaged in a quarrel as to which should have her as his wife. The star-gazer said, "If I had not espied her, all your arts would have been futile; therefore she is mine." As all their claims were of equal merits, the king decided that no one should get her, but assigned to each a half kingdom as his reward.

Lucian, in his "True History" (I, 26), relates that in the palace of Endymion, king of the moon, he saw a large mirror placed above a well of mediocre depth. In descending into this well, it was possible to hear whatever was talked on earth; and in lifting one's eyes toward the mirror, one saw all towns and all nations as though one were in their midst. "I saw there my parents and my country," he adds, "I do not know whether they saw me too. I do not venture to affirm it, but he who declines to

believe me might go to the moon, and will then convince himself that I am not an impostor."

Zosimus, an alchemist who lived in Egypt during the third and fourth centuries A.D., discusses the electron, an alloy of gold and silver, and mentions a magic mirror which Alexander the Great had made of it and which subsequently was exhibited in the Temple of the Seven Gates (corresponding to the seven heavens) above all spheres. In this mirror one beheld one's own future and destiny until one's death. This was a divine mirror symbolizing God (compare Epistle of James, I, 23-24; I Corinthians XIII, 12; II Corinthians III, 18).

In 331 B.C. Alexander the Great founded the city named for him—Alexandria. About 280 B.C. the famed Pharos was constructed there by Sostratus of Cnidus—the earliest lighthouse known in history. It was about three hundred feet high, a three-storied structure; the lower story was square, the middle one octagonal, the upper one, which contained the light, circular and surmounted by a colossal statue of Poseidon (Neptune). The Pharos of Alexandria became widely known in the Islamic world, but Mohammedan authors erroneously attribute its foundation to the great world-conqueror himself, designating it Menarat Iskanderiah ("Lighthouse of Alexander"). They describe it as one of the marvels of the world. On the top of this lighthouse, they say, Alexander placed a magic mirror in which could be sighted all incoming ships, the country Rum (the Byzantine empire), the islands of the sea and whatever was done by the inhabitants. By virtue of this mirror, as long as it existed, the city of Alexandria was said to preserve its grandeur and power. The Persians called this lighthouse Mirror of Alexander (Aineh Iskenderi), believing that the fortunes of Alexandria depended on it, as it was a talisman con-

structed under the influence of a certain constellation. It is said to have broken to pieces shortly before the city was conquered by the Arabs in A.D. 641.

Rabbi Benjamin of Tudela, who traveled in the Orient between the years 1159 and 1173, mentions the high tower of Alexandria surmounted by a glass mirror by means of which the approach of a ship or a hostile fleet could be noticed even when it was a twenty days' voyage off. The city was therefore prepared for the reception of a hostile ship from whatever direction she approached. Once, however, when Greece was still subject to the Alexandrians, Benjamin continues, a Greek vessel cast anchor in the port of Alexandria. The captain, a Greek, Theodorus by name, instructed in all sciences, brought to the Egyptian king valuable presents of gold and silver, silk and purple. His ship was at anchor opposite the lighthouse. Every day the captain invited the guard of the lighthouse with his servants on board his ship until they were on friendly terms. One day he treated them to an opulent feast and filled them with wine till they were intoxicated and fell into a deep slumber. The captain then ordered his crew to smash the mirror, and set sail the same night. From that time onward Christian ships, small prowlers as well as large vessels, entered the port, and snatched away two large islands, Crete and Cyprus, which are still under Christian rule. Egypt was henceforward unable to resist the Greek power.

Leo Africanus, in his "History of Africa," writes that the mirror of Alexandria was of "steel glass" by the hidden virtue of which passing ships, while the glass was uncovered, should immediately be set on fire; but when the glass was broken by the Mohammedans, its secret virtue vanished.

The fame of Alexandria's Pharos and television mirror even spread to the Far

East. Chao Ju-Kwa, who was stationed as inspector of maritime trade at the port of Ts'üan-chou in Fu-kien and collected there from the lips of foreign traders much interesting information on the countries of the Indian Ocean, which he published in his "Chu fan chi," written in A.D. 1225, gives a brief notice of Alexandria and its lighthouse. "On the summit of it," he writes, "there was a wondrous large mirror. In the event of a surprise attack by foreign warships they would be detected beforehand by this mirror, and the troops on guard duty were ready to meet the situation. In recent years Alexandria was visited by a foreigner who asked for work in the guardhouse of the tower and who was employed as a janitor. He was not suspected for years, when suddenly he seized an opportunity of abstracting the mirror and flung it into the sea, whereupon he disappeared." A late Chinese cyclopedia (*San ts'ai t'u hui*) has disfigured this tradition considerably by stating that Tsu-ko-ni (Alexander) erected in Egypt a temple on the top of which there was a mirror which when pirates of other countries made a raid reflected them and thus announced their arrival.

In the famous letter of Prester John (71) purporting to have been written by him to the Byzantine emperor, Manuel (1143-80), is described a marvelous mirror which is reached by ascending a hundred and twenty-five steps over an elaborate structure of pillars. In this mirror all plots and machinations and everything that was done in the adjacent and subjected provinces either on behalf of Prester John or against him would be clearly revealed and recognized; day and night it was guarded by twelve thousand armed men that it might not be broken by an accident. In the work of Johannes Witte de Hese (1389) this mirror of Prester John is also mentioned: three precious stones are deposited in it; one of these

directs and sharpens the vision; another, the senses; the third, experience; three very capable doctors have been elected to examine the mirror and see in it everything that is done in the world.

A "History of the World" published in Neo-Greek by Dorotheos, metropolitan of Malvasia, at Venice in 1763, alludes to a magic mirror in the imperial palace of Constantinople made by the emperor Leo the Philosopher: whatever existed or happened or was intended to be done in the world could be most clearly visualized in this mirror. The Emperor Michael, who was given to a voluptuous life, was informed one day by a messenger that he had beheld in the mirror the war preparations of the Turks against Constantinople. Michael, who just pampered at a banquet, did not like to be disturbed and ordered a servant to smash the mirror to atoms.

According to an Arabic tradition, Saurid was the wealthiest king on earth and had a mirror made from various alloys, wherein he could scan whatever occurred in the seven zones, whether good or bad, and what land was irrigated or not. This mirror was placed in

the city of Amsus on the top of a green marble column. In the city of Sa on the bank of the Nile stood a pillar of white marble and upon it a mirror in which King Sa, for whom the city was named, was able to discern whatever happened in the seven zones.

Spencer, in his "Fairy Queen," has Merlin make a magic mirror in which a girl beholds the image of her swain. Walter Scott, in his "Lay of the Last Minstrel," relates that Cornelius Agrippa showed the Count of Surrey, during his sojourn in Italy, his sweet-heart Geraldine in a mirror as she was reclining on a couch and reading her lover's poems by the light of a wax candle.

Nathaniel Hawthorne, in his story "Dr. Heidegger's Experiment," refers to a looking-glass hung in the doctor's room, "presenting its high and dusty plate within a tarnished gilt frame. Among many wonderful stories related of this mirror, it was fabled that the spirits of all the doctor's deceased patients dwelt within its verge, and would stare him in the face whenever he looked thitherward."

A SUBSTITUTE FOR ARSENIC

By S. MARCOVITCH

TENNESSEE AGRICULTURAL EXPERIMENT STATION

DON MARQUIS in his book "Archie and Mehitabel" puts the following words in the mouth of Archie the cockroach:

i am going to start
a revolution
i saw a kitchen
worker killing
water bugs with poison
hunting pretty
little roaches
down to death
it set my blood to
boiling

i thought of all
the massacres and slaughter
of persecuted insects
at the hands of cruel humans
and i cried
aloud to heaven
and i knelt
on all six legs
and vowed a vow
of vengeance
i shall organize the insects
i shall drill them
i shall lead them
i shall fling a billion
times a billion billion



Inspirational Dreams in Eastern Asia

Author(s): Berthold Laufer

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INSPIRATIONAL DREAMS IN EASTERN ASIA.¹

BY BERTHOLD LAUFER.

In discussing briefly the subject of inspirational dreams I must disclaim at the outset any technical knowledge of dream psychology. There is a vast literature on this subject chiefly produced by psychiatrists like Freud and Kraepelin and psychologists, most of which I confess I have not read and may never hope to have the time to read. The best introduction to the subject for our purposes is that of an orientalist, Georg Jacob, whose book is entitled "*Märchen und Traum*" (Hannover, 1923), written with special reference to the Orient and provided with a good bibliography.

My main object in presenting these remarks is to call the attention of our ethnologists interested in the inspirational dreams of the North American Indians to some striking parallels in eastern Asia and to stimulate them to a more profound investigation of this interesting problem, which has been but little studied and which I believe will be better comprehended with due consideration of corresponding phenomena in other culture areas.

Although the scientific study of dreams is still in its initial stages and the interpretation of cases and symptoms varies to a great extent, it is quite safe to assert now that dreams have exerted an enormous influence on the formation of human behavior and culture. Many motives of legends and fairy tales have justly been traced to dreams; many mythical concepts and motives of art and even entire works of art have been inspired by them. It is infinitely more probable that the majority of fabulous monsters and chimaeras which so abundantly pervade all oriental arts owe their origin to visions and dreams than, as has been suggested, to the discovery and imaginative reproduction of real fossil monsters. As may be expected, the exaggerations of the specialist have also been at work in this field; and as we have pan-sexualists, who reduce everything to sex, so there are also "pan-dreamists" (or pan-oneiromantists) who exert themselves to trace all happenings to dreams.

Both India and China possess an ancient literature on dreams, and from earliest times have had a special class of dream interpreters to whose verdicts great attention was paid. Many hundreds, more probably even thousands, of dreams are recorded in the Chinese annals and in the biographies of individuals, and have had a sometimes far-reaching effect on the course of historical events; but despite this abundance of material no one has ever made a special study of Indian or Chinese dreams. Of all

¹ Read at the Meeting of the Central Section of the American Anthropological Association, Milwaukee, May 9, 1930.

categories of dreams the inspirational dream is the most interesting, because it has proved a creative force in literature, science, and art, or stimulated ambition or provoked activity of one sort or another.

An inspirational dream opens the history of the conversion to Buddhism of the Mongol emperors. This conversion was accomplished by the Grand Lama of the famous Sa-skya monastery in Tibet, 50 miles north of Mount Everest. This was Blo-gros rgyal-mts'an, usually called by his title P'ags-pa ("Reverend"). He was summoned to Peking by the emperor Kubilai in A. D. 1261, who received from him the Hevajra consecration. Hevajra is the name of a mystic Buddha.

The Mongol chronicler Sanang Setsen narrates that on the first day when the Tibetan church dignitary had an audience with the Grand Khan he was unable to answer any questions put to him by his majesty and could not even comprehend a single word of what he said. Deeply alarmed, he begged the emperor to be excused and to be allowed to continue the conversation the following day. The cause of his incompetence was that the text of the Tantras (magic spells) of Hevajra, which formerly was the property of the Sa-skya family, was now in the hands of the Grand Khan, and that P'ags-pa had not seen the book. In consequence the saint passed a night full of sorrow and anguish. During that night he had a dream of an old man, who had the appearance of a Brahman, with snow-white hair tied into a knot on the crown of his head, holding in his hand a flute made from a human thighbone. This old man ordered P'ags-pa to light a lamp, and then produced a box from which he took a book that contained the text of the Hevajratantra. P'ags-pa perused the book in his dream and memorized its contents. On the following day he was able to answer the emperor's questions, gave him his benediction, and received the title "king of the doctrine in the three countries [i. e. China, Tibet, and Mongolia], the holy Lama." The old man who had appeared to him in his dream was the tutelary god Mahākāla ("the Great Black One"), a form of Çiva. In fact, a brass or bronze image of Mahākāla in the form of a Brahman, holding a bone flute, such as P'ags-pa saw in his vision, still exists.¹ This role of Çiva-Mahākāla as an inspirationalist is of ancient date in India. The most perfect grammar produced in India, that of Pāṇini, is ascribed to an inspiration of this god.

Inspirations obtained by dreams play an extensive role in the latest, mediaeval phase of Buddhism, the Yoga or Tantra school, which combined the teachings of Mahāyāna Buddhism with the mystic doctrines of the Yoga system of Patañjali. This system consisted chiefly in the practice of magic and sorcery aiming at endowment with supernatural, miracle-working power. This was attained by recitation of mystic formulas (*tantra*), litanies, or spells accompanied by music and certain positions or distortions of the fingers (*mudrā*). Mental concentration on a single

¹ A. Grünwedel, *Mythologie des Buddhismus*, pp. 54, 63—64, 176.

point was required with a view to annihilate thought, and resulted in a mental and physical coma, auto-suggestions, visions, and dreams. The spells and the magical powers obtained from them were in the hands of certain deities, who had to be exorcised, so that it is no wonder that these appeared to the visionaries in their dreams and inspired them to write certain books or to visit a certain country for the purpose of propagating religion. Thus, Čānti is instructed by the goddess Tārā in a dream to go to Ceylon to preach the Mahāyāna; Abhayākara Gupta is visited twice in a dream by the goddess Vajravārāhi, who exhorted him to write manuals and obtain salvation through her.¹ Other saints, by beholding the face of a god in a dream, obtained the highest miraculous powers, such as lightening their bodies, flying through the air, assuming any shape, reaching any place, etc.

The Chinese theory of dreams is as follows: A double soul is distinguished in every individual — a material or animal soul called *p'ō*, which regulates the functions of life, is indissolubly attached to the body and goes down to earth with it after death; and a spiritual soul, called *hun*, which governs the functions of reason, is able to leave the body and at death goes to heaven, carrying with it an appearance of physical form. A dream arises when the connection of the body with the spiritual soul is interrupted. The body lives as long as the material soul dwells in it, but is doomed to die as soon as it escapes. The spiritual soul, however, may leave the body without endangering its life. This is the case in swoons, trances, and dreams. The soul separates from the body and enters into communication with spirits; it may freely interview the souls of the departed or have speech with the gods. At the end of the dream the soul returns to the body.

The Chinese are perhaps the only people who have conceived a way of representing dreams pictorially. From the head of the sleeper radiates a fluttering band or the dream-path in form of a lane on which are drawn or painted the figures appearing in the dreamer's vision. A beautiful example of this kind may be seen in Field Museum, carved on a rhinoceros-horn cup where a handsome maiden asleep dreams of her Prince Charming.

The form of dream known as incubation or temple sleep formerly played a prominent role in China. Every town has a tutelary god styled "the father of the walls and moats" (Ch'eng Huang Ye) and worshiped in a special temple. These city gods are defunct and deified officials who, during their tenure of office, had merited appreciation from the city under their administration. The city god cares for the welfare of the inhabitants under his jurisdiction, and is the mediator between this and the other life, keeping an account of all good and evil deeds of his protégés and reporting these to the gods of Heaven and Hell. The worship of city

¹ Grünwedel, Taranatha's Edelsteinmine, pp. 110, 112, 113.

gods reached its climax toward the end of the fourteenth century under the first emperor of the Ming dynasty. At that time it was obligatory for all officials of higher ranks when entering a walled city to pass the first night in the temple of the city god, in order to receive his instructions in a dream. In case of a difficult point in law judges will spend the night in the city god's temple, in the hope that the god will appear to them in a dream and enlighten them on the case in question. Sometimes a district magistrate or judge will adjourn his court to the temple hall in order to give solemnity to the trial, to intimidate the witnesses or to encourage them to speak the truth. The temple sleep is always preceded by bathing and fasting, and the official betakes himself to the temple in a solemn procession. Sometimes a written petition is burnt before the altar of the god with proper ritual, and then the official retires to rest in an adjoining room. There are stories to the effect that ashes of the burnt document had, traced in them, the name of the guilty person and the place where he lived, whereupon he was duly brought to justice.¹

Not only officials, but also plain people, in case of a difficult decision, resort to the expedient of seeking a dream by visiting a temple; burning incense, they invoke the deity to favor them with a dream that will shed light on the subject of their perplexity. They frequently go to sleep before the image of the god. Should they have a dream, they rise and inquire by means of a certain process of divination whether the dream was really sent by the god in answer to their prayer. When an affirmative reply is received, they proceed to study the character of the dream or consult a dream interpreter to decide on a course of action.² In the province of Fu-kien it is customary for people to sleep on a grave for the purpose of provoking a revelation in a dream.³ This custom reminds one of what Herodotus (IV, 172) reports anent the Nasamones who predict the future by visiting the graves of their ancestors, where they pray and fall asleep and act in accordance with their dreams.

Examples of inspirational dreams are known from China prior to the introduction of Buddhism. Thus, Confucius in his earlier years had frequent dreams of Chou Kung, his ideal in political wisdom, whose principles and institutions he endeavored to put into practice; and when he grew old and disillusioned, he complained that "for a long time he had not dreamt, as he was wont to do, of the Duke of Chou."⁴ Confucius is also said to have received a premonition of his coming death through a dream, in which he saw himself seated between the two pillars of the platform in front of his house, receiving offerings due to the dead. Seven days later he died.⁵

¹ cf. G. Willoughby-Meade, *Chinese Ghouls and Goblins*, p. 85.

² cf. J. Doolittle, *Social Life of the Chinese*, 1868, p. 449.

³ De Groot, *Fêtes*, p. 593.

⁴ *Lun yü*, VII, 52.

⁵ Legge, *Li ki*, I, p. 138; Chavannes, *Se-ma Ts'ien*, V, p. 424.

Another inspirational dream of ancient date, in which a portrait is in question, is of interest. When Wu Ting (1324—1266 B. C.), a ruler of the Yin or Shang dynasty, lost the services of his aged teacher Kan-p'an, who advised him on government affairs, he was in quest of a new counselor. Therefore he addressed a prayer to Shang-ti, the supreme god, requesting that he should reveal to him in a dream the man capable of acting as his prime minister. In his dream he really saw the likeness of the man selected by God, but he could not find him among the high dignitaries of the empire, though he searched all over the country. A portrait was then made of the man, as he had appeared to the emperor in his dream, and this was circulated throughout the empire. Finally this led to the discovery of the man in the person of a common workman, Fu Yüe by name, who was raised to the post of prime minister.¹

Tao K'an, a celebrated Chinese statesman (A. D. 259—334), once had a dream which led to his advancement. He dreamed that he scaled the heights of heaven with the aid of eight wings, and passed through eight of the celestial doors, but was driven back from the ninth by the warder, who cast him down to earth. When he landed there, the wings on his left side were broken. Subsequently he entered public life, and was appointed governor of eight provinces, which was interpreted as a realization of his dream.

T'ang Li-yüan, when he crossed the Yang-tse River, noted in it the body of a woman, pulled it out of the water, and buried it. During the night he dreamed that he found himself in a place like a recess deep in a mountain; the bright moon had just risen above the horizon, a gentle breeze played with his garments, and in the distance was audible a tune produced by a reed organ, the tones of which melted sweetly away. Suddenly a beautiful woman appeared at the edge of the woods and sang this tune: 'The melodies of the Purple Mansion (the heavenly spheres) can be clearly heard in succession in a pure clear night such as this.' Subsequently T'ang Li-yüan presented himself in the capital at the examinations for the highest literary degree. The theme assigned to the candidates for writing an essay was as follows: 'In the Hou Mountains, Wang Tse-tsin is heard playing on a reed organ during moonlit nights.' Li-yüan now used the lines he had heard in his dream as the third and fourth lines in his composition. In consequence he was successful and won the degree of *tsin-shi*. The people considered this as a reward bestowed upon him by the spirit of the woman for whom he had provided burial.

A well-defined artistic composition connected with dreams is presented by the Arhats or, as the Chinese say, Lo-han. The Arhats are the most advanced disciples of the Buddha, who have reached the highest degree of saintship, and are considered the most powerful protectors of the Buddhist religion. They usually appear in a group of sixteen to which

¹ *Shu king*, IV, VIII, 2—3.

at a later time two were added in China. They play the same role in Chinese religion and art as the apostles in Christendom, and their portraits and statues rank among the foremost productions of Chinese art. The creator of the Arhat types was a Buddhistic monk, Kwan Hiu, who lived from A. D. 832 to 912, up to the age of 81. He became a novice in the monastic order when he had reached the age of seven, and belonged to the sect known as Dhyāna ("contemplation"), the chief aim of which was to obtain self-perfection and salvation through inward concentration and meditation. From meditation to visionary dreams there is but one step. Kwan Hiu was a precocious youth famed for his poetry among his contemporaries, but he soon developed into a greater artist with the brush, specializing in portraits of the Arhats which designated a novel departure from the established routine. In his biography it is said, "Every time he desired to paint one of the venerable saints, he first recited a prayer, and then in his dreams obtained the respective figure of the Arhat. Awakening, he fixed this dream picture in his mind and painted it accordingly, so that his portraits did not conform to the customary standard."¹ Like a Crow Indian, who sought directions for the decoration of his shield in a dream, Kwan Hiu was in deliberate quest of a vision. In another source (*Yi chou ming hua lu*) it is on record, "Kwan Hiu painted the pictures of the sixteen Arhats with long bushy eyebrows, with drooping cheeks and high noses, leaning against a pine-tree or a rock, or seated in a landscape, men of a strangely foreign appearance or a Hindu face. When people marveled at his pictures and interrogated him, he replied, 'I paint what I see in my dreams.'" In honor of this artist, a temple was erected at She (in Hui-chou fu, An-hui-Province), called the "Hall of the Arhats Corresponding to Dreams."

This account of Kwan Hiu's Arhat portraits is by no means fanciful, but thoroughly authentic and in consonance with the facts. Hundreds and thousands of Arhats have been painted in China in the course of many centuries, and whatever differences of style and composition there may be, there are only two fundamental types of Arhat — a naturalistic type and a dream type traceable to Kwan Hiu as his father. The naturalistic type is based on close observation of Indians who came from India to China, and the Chinese artists reveled in portraying exactly their prominent racial features. What Kwan Hiu did in consequence of his dreamy visions was to exaggerate with grotesque humor the Indian racial characteristics, equipping them with strangely formed, hill-shaped heads, peculiarly curved noses, protruding eyeballs, excessively long eyebrows, wild curly beards, crooked and bent bodies in almost impossible positions; although seemingly grotesque caricatures, yet personifications of sublime sainthood. Since they do not conform to any reality, we are

¹ S. Lévi and E. Chavannes, Les seize Arhat protecteurs de la loi, *Journal asiatique*, 1916, II, p. 300.

compelled to admit that they must be the result of dream revelations and that the tradition of Kan Hiu's dream pictures is correct.¹

Tang Hou, author of a treatise on painting (*Hua kien*), has this story: "Hui Tsung painted with his own hand a picture entitled 'A Dream Journey to the Other World.' The inhabitants, several thousands in number, were about half the size of one's little finger. All things in heaven and earth, most beautifully executed, were to be found therein — cities with their suburbs, palaces, houses, banners, pennants, bells, drums, beautiful girls, souls of men, clouds, red glows, mists, the Milky Way, birds, cattle, dragons, and horses. Gazing at this picture makes one feel a longing to travel away into space and forget the world of men. Verily it is a marvelous work."² Such dream pictures describing scenes in the beyond were numerous, or rather the things and spirits encountered in the other world were revealed in dreams. Another famous subject of this kind is the emperor Ming Huang's aerial journey into the palace of the moon. In general it may be asserted that all notions of a supernatural world and the beliefs in the immortality of the soul have largely been inspired and influenced by visions and dreams.

Both in India and China we must discriminate between two types of inspirational dream — the real one or subjectively true one and the dream as a purely literary motive or pattern. The latter, naturally, is a later development which has grown out of the former. The development is the same as in art where conventionalized motives go back to spontaneous or realistic ones or where copies and copies of copies are traceable to one original prototype. India and China offer hundreds of examples of the literary dream pattern. In the 550 Jātakas or birth-stories of the Buddha, when he still was a Bodhisatva and appeared in all sorts of animal incarnations, there are at least a dozen stories in which a queen or princess dreams of a golden peacock, a golden stag, a golden deer, or a six-tusked elephant able to preach the law of salvation; she falls ill from yearning for this wonder of nature until the animal is captured by order of the king after many strenuous efforts and queen and king are ultimately converted to Buddhism by the Bodhisatva. In the legendary biography of Buddha nearly every important event is accompanied by a prophetic dream. In a similar manner the introduction of Buddhism into China is ascribed by tradition to a dream of the emperor Ming of the Han dynasty (A.D. 61) in which a golden image appeared to him soaring in the air above his palace. This statue was interpreted by the emperor's brother as that of Buddha, and the dream resulted in an embassy being sent to India for teachers and scriptures. This is merely a legend invented at a later time by the clergy for the edification of the pious;

¹ For reproductions of Kwan Hiu's paintings see Laufer, *T'ang, Sung and Yüan Paintings*, plates VII—VIII.

² Giles, *Intro. to History of Chinese Pictorial Art*, 2d ed., p. 136.

Buddhism, in fact, was known in China long before this alleged dream episode.

The distinction here made, *mutatis mutandis*, is also traceable among the Plains Indians, save that the historical connections are lost here. According to Wissler, the putative dream designs of the Dakota do not differ in principle from other designs, and a dream design is not so much a distinct type of design as an illustration of the manner in which Dakota philosophy accounts for the origin of the present styles of decorative art.¹ In my opinion there must have been in the past a group of Dakota designs inspired by dream notions which were handed down from generation to generation; the decorative motives may have changed in the course of time, while the original dream story persisted or evolved into a mere pattern.

Inspirational dreams occasionally occur in European folklore also; for instance, in the cycle known as "the dream of the treasure on the bridge." A fishmonger dreams that he will find his fortune under a certain bridge, but when he betakes himself to the spot, he finds there only a beggar in tatters. Disgusted, he is about to get away when the beggar reveals to him a spot where he will find a hidden treasure that will make him a rich man.² This treasure motive also occurs in China, and I will conclude with a Chinese dream story that at the same time contains an amusingly correct explanation of dream phenomena. It is a monologue recited on the stage in a fast tempo to the accompaniment of castanettes.³ "I want to tell you a fine story. It is regrettable how unjust Heaven is; he sends rain and snow down upon us, but no lumps of silver. Last night I lay on my bed, tossing around sleeplessly. I was awake from the first till the second night-watch, and again from the second till the third was beaten. Then I saw a dream in my sleep. I dreamt of a treasure buried to the south of the village. I therefore seized spade and hoe and went out into the field to dig for the treasure. I really was in luck; after a few blows with spade and hoe I hit upon the treasure. It was a whole cellar full of silver ingots, wrapped in a large rush-mat. I lifted the mat and looked beneath it. Ah, I burst into laughter: there were a coral tree thirty feet high, genuine red carnelian and white agate. I picked up seven or eight sacks full of diamond-points, six large baskets full of cat's-eyes, thirty-three striking clocks, sixty-four ladies' watches, fine boots and caps, handsome garments, fine fashionable hand-bags, seventy-two large gold ingots, and in addition thirty-three thousand, three hundred and thirty-three silver shoes inlaid with enamel work. Now I had so much gold and silver that I didn't know what to do with it. Should I buy land for it and till the

¹ Cf. R. Lowie, *Primitive Religion*, p. 289.

² F. Liebrecht, *Zur Volkskunde*, p. 93.

³ W. Grube, *Chinesische Schattenspiele*, p. 440.

ground? I was afraid of drought and inundations. Or should I go into the grain business? But the rats might eat up my whole stock. Or should I lend money on interest? But I lacked bail. Or should I open a pawnshop? I feared that I might lose money; for if the manager would run away with the capital, where should I look for him? Pondering over these thousand difficulties I got so agitated that I awoke with excitement, and lo and behold, it was merely a dream! Both my hands had fumbled with the bed and had caught the tinder-box with flint and steel: this was the silver shoes of my dream. Then I had seized the brass tobacco-pipe: this was the ingots of gold. After groping around in the dark for a while, I hit upon a green-headed large scorpion which stung me so that I screamed and yelled with all my might."